

# Operating Instructions

Diesel engine  
20 V 4000 C22

M015675/05E



*Power. Passion. Partnership.*

Printed in Germany

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

# Commissioning Note

## Important

Please complete and return the "Commissioning Note" card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).



### Postcard

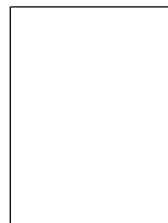
**MTU Friedrichshafen GmbH**

**Technical Information Management**

**Dept. VOT**

**88040 Friedrichshafen**

**GERMANY**



**Engine No.:**

**MTU works order no.:**

**Engine model:**

**Date put into operation:**

**Application: \***  
☐ Marine      ☐ Rail  
☐ Genset      ☐ .....

**Type:**  
**Manufacturer:**

**End user's address:**

**Remarks:**



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# 1 Safety

## 1.1 General conditions

### General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention and environmental protection must be observed. This state-of-the-art engine has been designed to meet all applicable laws and regulations. The engine may nevertheless present a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the Safety Instructions

### Correct use

The engine is intended solely for use in accordance with contractual agreements and the purpose envisaged for it on delivery. Any other use is considered improper use. The engine manufacturer accepts no liability whatsoever for resultant damage or injury in such case. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the operating instructions and maintenance and repair specifications.

### Modifications or conversions

Unauthorized modifications to the engine represent a safety risk.

MTU will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

### Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. MTU accepts no liability whatsoever for damage or injury resulting from the use of other spare parts and the warranty shall be voided in such case.

### Reworking components

Repair or engine overhaul must be carried out in workshops authorized by MTU.

## 1.2 Personnel and organizational requirements

### **Personnel requirements**

Work on the engine must only be carried out by appropriately qualified and instructed personnel.

Observe the minimum legal age.

Responsibilities of the operating, maintenance and repair personnel must be specified by the operating company.

### **Organizational measures**

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep it handy in the vicinity of the engine such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Use the manual as a basis for instructing personnel on engine operation and repair. In particular, personnel must have read and understood the safety-relevant instructions.

This is especially important for personnel who work on the engine only on an occasional basis. These persons shall receive repeated instruction.

Use the Spare Parts Catalog to identify spare parts during maintenance and repair work.

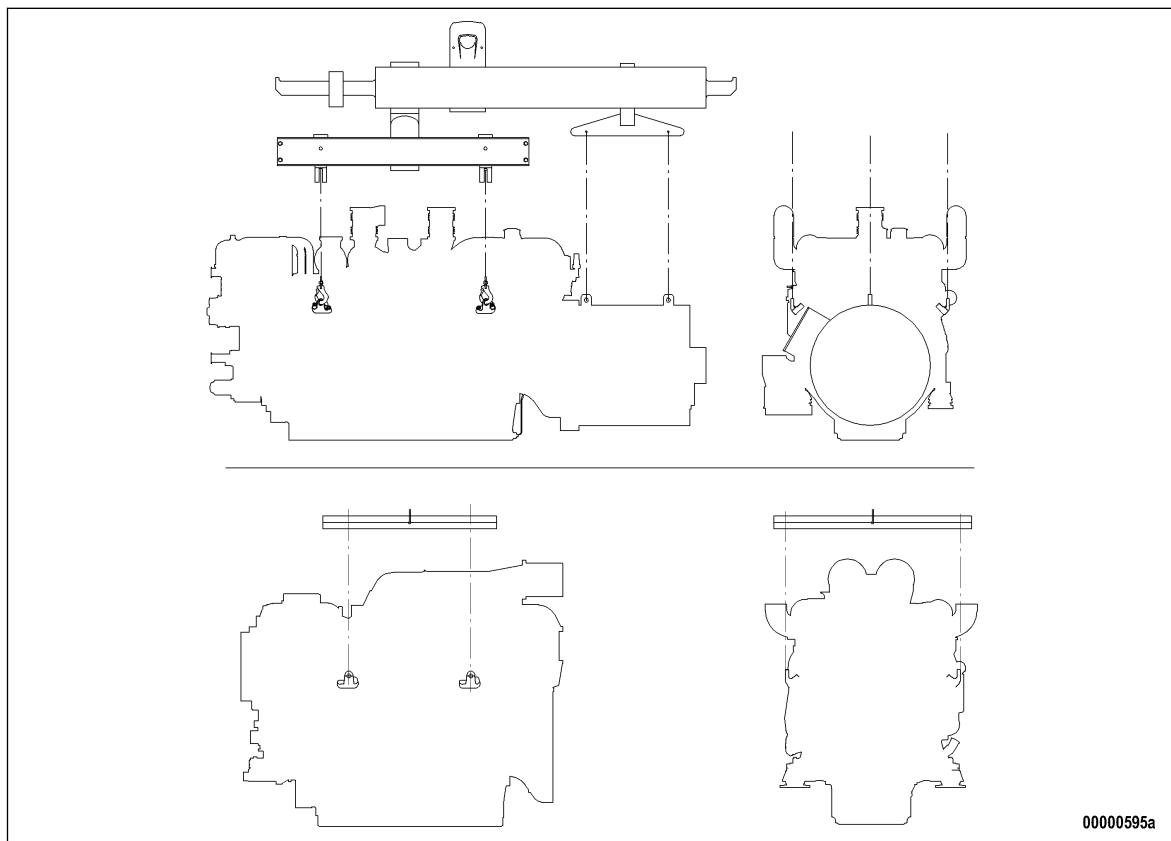
### **Working clothes and protective equipment**

Wear proper protective clothing for all work.

Depending on the kind of work, use the necessary personal protective equipment.

## 1.3 Transport

### Transport



Always use the lifting eyes on the engine and generator/gearbox when transporting gensets.

Always use the lifting eyes on the engine when transporting an engine separately.

Only use transport and lifting devices approved by MTU.

Transport the engine/genset in the installation position only, maximum admissible inclination is 10°.

Remove any loose parts on the genset.

Hoist the engine/genset slowly ensuring that lifting cables/chains do not touch the engine or any of its component parts. Readjust lifting device as necessary.

Pay attention to the center of gravity of the engine/genset.

When specially wrapped in aluminum foil, suspend the engine/genset by the lifting eyes on the bearing pedestal or transport by means of handling equipment (forklift truck) capable of bearing the load.

Fit the crankshaft shipping lock on the engine and fit the engine mount locking devices prior to transport.

Secure the engine/genset such as to preclude tipping during transport. Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

### Placement after transport

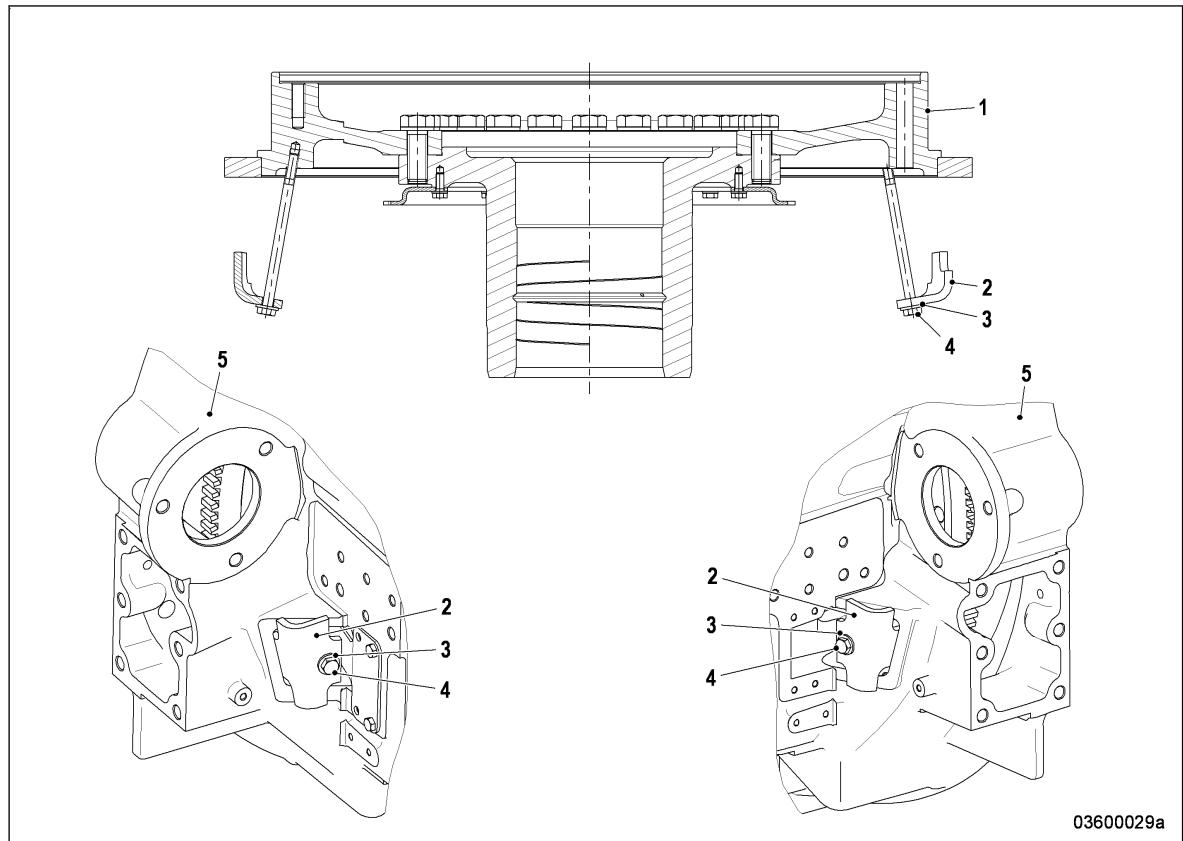
Place the engine/genset on a firm, flat surface only.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressly authorized to do so by MTU on a case-to-case basis.

## 1.4 Crankshaft transport locking device – For transport with flanged-on generator

### Transport



This locking device protects the crankshaft bearings from shocks and vibration damage during unit transport.

For removal of the transport locking device follow the following instructions:

- The transport locking device should remain installed as long as possible during unit installation in order to avoid damage.
- Starting or barring the engine is allowed only with the transport locking device removed. Make sure that the transport locking device of the generator is removed.
- Prior to every unit transport, this transport locking device must be reinstalled according to the instructions. The transport locking device of the generator is also to be fitted.

### Removing the transport locking device from driving end (KS)

- Remove screw (4) on both sides. Remove retainer (2) and washer (3).
- Remove guard plate from flywheel housing.

Store the removed parts of the transport locking device carefully for possible reuse!

### **Fitting the transport locking device on driving end (KS)**

- Remove protective cover from flywheel housing (5).  
Keep guard plate and screws on the engine. They must be reinstalled when the transport locking device has been removed.
- Turn crankshaft to bring cylinder A1 in TDC position.
- Check the threads on both sides of the flywheel (1) for ease of movement.
- Install retainer (2) with screw (4) and washer (3) through the opening in the flywheel housing (5) . Lubricant: engine oil.
- Tighten screw (4) in three steps. Tightening torque: 50 +5 Nm.
- Mark the engine as "Fitted with transportation locking device".

## 1.5 Safety regulations for startup and operation

### Safety requirements for initial operation

Prior to initial operation of the unit, install the assembly or unit according to the specifications and check the installation according to the MTU specifications.

Before putting the device or plant into operation, always ensure:

- that all maintenance and repair work is completed,
- that all loose parts have been removed from rotating machine components,
- that nobody is in the danger area of moving machine parts.

Immediately after putting the device or plant into operation, make sure that all control and display instruments as well as the signaling and alarm systems work properly.

### Safety requirements for operators

The procedures for cases of emergency must be practiced regularly.

The operator must be familiar with the control and display elements.

The operator must be familiar with the consequences of any operations performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:

- inform supervisor(s) in charge,
- analyze the message,
- if required, carry out emergency operations e.g. emergency engine stop.

### Engine operation

The following conditions must be fulfilled before starting the engine:

- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale engine exhaust gases.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, battery-charger terminals and cables against accidental contact.
- When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

### Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.



## 1.6 Explosion hazard when removing inspection port cover on engine

DANGER



Explosion hazard due to oil vapors.

**Risk of serious injury – danger to life!**

- Allow the engine to cool down before opening the crankcase!
- Avoid open flames, electrical sparks and ignition sources.

### Safety instructions

- Before starting maintenance work, allow the engine to cool down for at least 10 min. (danger of explosion due to oil vapors).

## 1.7 Safety precautions when working on the engine

### Safety requirements for maintenance and repair work

- Maintenance and repair work may only be carried out by authorized, qualified personnel.
- Allow the engine to cool down before commencing maintenance work (oil vapors present a risk of explosion).
- Before starting work, relieve pressure in systems and compressed-air lines which are to be opened.
- Take special care when removing ventilation or plug screws from engine. Cover the screw or plug with a rag to prevent fluids escaping under pressure.
- Take special care when draining hot fluids ⇒ risk of burning.
- When changing the engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.
- Prior to all work, allow the engine / genset to cool down.
- Observe maintenance and repair instructions.
- Never perform care or maintenance work with the engine running unless expressly instructed to do so.
- Lock-out/tag-out the engine to preclude undesired starting.
- With electric starter, disconnect the battery.
- Close the main valve on the compressed-air system and vent the compressed-air line when air starters are fitted.
- Disconnect the control device from the assembly or plant.
- Only use adequate, calibrated tools. During assembly and disassembly, observe the specified tightening torques.
- Carry out work only on assemblies or plants that are secured as specified.
- Do not use lines as climbing aids.
- Keep fuel injection lines and connections clean.
- Always fit caps/covers to close off any openings exposed by removing or opening lines.
- Take care to avoid damaging fuel lines in the course of care and maintenance work.
- Ensure that all mounts and dampers are correctly installed.
- Ensure that all fuel injection and pressurized oil lines are installed with enough space to prevent contact with other components. Do not place fuel or oil lines near hot components.
- Do not touch elastomeric seals (e.g. Viton sealing rings) if they have carbonized or resinous appearance.
- Note cooling period for components which are heated for installation or removal ⇒ Risk of burning!
- When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.
- Observe special cleanliness during maintenance and repair work on the assembly or plant. After completion of maintenance and repair work, make sure that no loose objects are in/on the assembly or plant.
- Ensure that all personnel is clear of danger zones before turning the engine. Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the engine.
- If starters with beryllium copper pinions are installed, the following also applies:  
To avoid health risks with the pinion containing beryllium, breathing protection of filter class P2 must be worn during maintenance work. Do not blow out the interior of the flywheel housing and the starter with compressed air. The interior of the flywheel housing must be additionally cleaned with a dust-removal machine of class H.

### Welding work

Never carry out welding work on the assembly or engine plant or mounted units. Cover the engine when welding in its vicinity.

Do not use the assembly or plant as a ground terminal.

Never place the welding cable across or near wiring harnesses of MTU plants. The welding current may otherwise induce an interference voltage in the wiring harnesses which could damage the electrical system.

If welding has to be carried out on components (e.g. exhaust manifold), these components must first be removed from the engine.

## Hydraulic installation and removal

Check the tools and devices to be used for perfect operation and safe condition. Only use the specified devices for force-fitting/removing parts.

Observe the maximum press-on pressure for the device for force-fitting/removing parts.

Do not attempt to bend or exert force on H.P. lines.

Observe the following before starting the pressing procedure:

- Bleed air from jigs and fixtures for force-fitting/removing parts, pumps and piping at the points provided for the system concerned (e.g. open threaded vent plugs, pump until no bubbles can be discerned in the oil, close threaded vent plugs).
- During the installation procedure, screw on device with pushed-in plunger.
- During the removal procedure, screw on device with retracted plunger.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation/removal of components, ensure that no persons are in the direct vicinity of the component being pressed.

## Working on electrical/electronic assemblies

Before starting any maintenance or repair work, or before switching off any electronic components necessary to carry out the work, permission must first be obtained from the relevant manager or supervisor.

Before work is carried out on the assemblies, the power supply to the relevant areas must be switched off.

Do not damage wiring during the removal work. When reinstalling, ensure that the wiring cannot be damaged during engine operation through contact with sharp edges, rubbing against a component or through contact with a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable clamps to secure the lines.

Only tighten union nuts of connectors with connector pliers.

On completion of all repair work, the device or system must undergo a function check.

Before replacement, ensure that spare parts are correctly stored, i.e. in particular, protected against moisture. Defective electronic components and assemblies must be suitably packed when dispatched for repair, i.e. in particular, protected against moisture and impact and wrapped in antistatic foil if necessary.

## Work with laser devices

When working with laser equipment, always wear special laser-protection goggles  $\Rightarrow$  eye injury through strongly concentrated beam.

Laser devices must be equipped, in accordance with their class and usage, with protective devices for ensuring safe operation.

For conducting light-beam procedures and measurement work, only the following laser devices may be used:

- Laser devices in classes 1, 2 or 3A.
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface have been designed in such a way as to prevent any risk to the eyes.

## 1.8 Fluids and lubricants, fire prevention and environmental protection

### Fire prevention

Correct fuel or oil leaks immediately. Quantities of oil or fuel on hot components can cause fires – therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying on or near the assembly or plant. Do not store inflammable material near the assembly or plant.

Do not weld pipes and components carrying oil or fuel. Before welding, clean with a nonflammable fluid.

When starting the engine with an external power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the external power source to the ground lead of the engine or to the ground terminal of the starter.

Always have a suitable extinguishing agent (fire extinguisher) on hand and familiarize yourself fully with its handling.

### Noise

Noise can lead to an increased risk of accidents if acoustic signals, warning shouts or sounds indicating danger are drowned.

At all workplaces with a sound pressure level over 85 dB(A), always wear ear protectors.

### Environmental protection and disposal

Modification or removal of mechanical or electronic components or the installation of additional components as well as the execution of calibration processes that might affect the emission characteristics of the engine are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by MTU. Noncompliance with these guidelines might represent a violation of the Clean Air Act and could involve the termination of the operating license by the emission authorities. MTU does not accept any liability for violations of the emission regulations. MTU will provide assistance and advice if emission-relevant components are intended to be modified. The MTU Maintenance Schedules ensure the reliability and performance of MTU engines and must be complied with over the entire life cycle of the engine.

Only fuels of the specified quality required to achieve emission limits must be used.

Dispose of used fluids, lubricants and filters in accordance with local regulations.

Batteries can be returned within the EU to MTU FN / MTU Onsite Energy free of charge for correct recycling/disposal.

### Fluids and lubricants

Use only fluids and lubricants that have been tested and approved by MTU.

Fluids and lubricants must be kept in suitable, correctly labeled containers. When using fluids, lubricants and other chemical substances, follow the safety instructions that apply to the product. Take special care when using hot, chilled or caustic materials. When using flammable materials, avoid all sparks and do not smoke.

### Used oil

Used oil contains combustion residue harmful to health.

Rub your hands with skin protection cream.

Wash your hands after contact with used oil.

## Lead

- When working with lead or lead-containing compounds, avoid direct contact to the skin and do not inhale lead vapors.
- Prevent the buildup of white powder of lead.
- Switch on fume extraction system.
- After coming into contact with lead or lead-containing materials, wash your hands!

## Compressed air

When working with compressed air, safety precautions must be constantly observed:

- Pay special attention to the pressure level in the compressed air network and pressure vessel!
- Assemblies or plants to be connected must either be designed for this pressure, or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection.
- Hose couplings and connections must be securely attached.
- Always wear protective goggles when blowing off tools or extracting chips.
- Provide the mouthpiece of the air nozzle with a protective disk (e.g. made of rubber).
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line, or before equipment or tool is to be replaced.
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class A1, A11 and B) out of containers, results in a risk of explosion!
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of bursting!
- Carry out the leak check as specified.

## Painting

- When carrying out painting work outside the spray stands provided with fume extraction systems, ensure that the area is well ventilated. Make sure that neighboring work areas are not impaired.
- No naked flames!
- No smoking!
- Observe all fire-prevention regulations!
- Always wear a mask providing protection against paint and solvent vapors!




## Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in specified containers without fixed covers.
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and protective goggles / safety mask!
- Make sure that working area is well ventilated.
- Take great care not to subject containers, fittings and tools to impact or shock.

## Acids/alkaline solutions

- When working with acids and alkalis, wear protective goggles or face mask, gloves and protective clothing.
- If acids or alkalis are spilled onto clothing, remove the affected clothing immediately!
- Rinse injured parts of the body thoroughly with clean water!
- Rinse eyes immediately with eyedrops or clean mains water!

## 1.9 Conventions for safety instructions in the text

<b>DANGER</b> 	In the event of immediate danger. <b>Consequences: Death or serious injury</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>WARNING</b> 	In the event of potentially dangerous situations. <b>Consequences: Death or serious injury</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>CAUTION</b> 	In the event of dangerous situations. <b>Consequences: Minor injury or material damage</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>

**Note:** This manual contains highlighted safety warnings in accordance with the US ANSI Z535 standard which begin with one of the signal words listed above depending on the severity of the hazard.

### Safety instructions

1. Read and familiarize yourself with all safety notices before starting up or repairing the product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel.

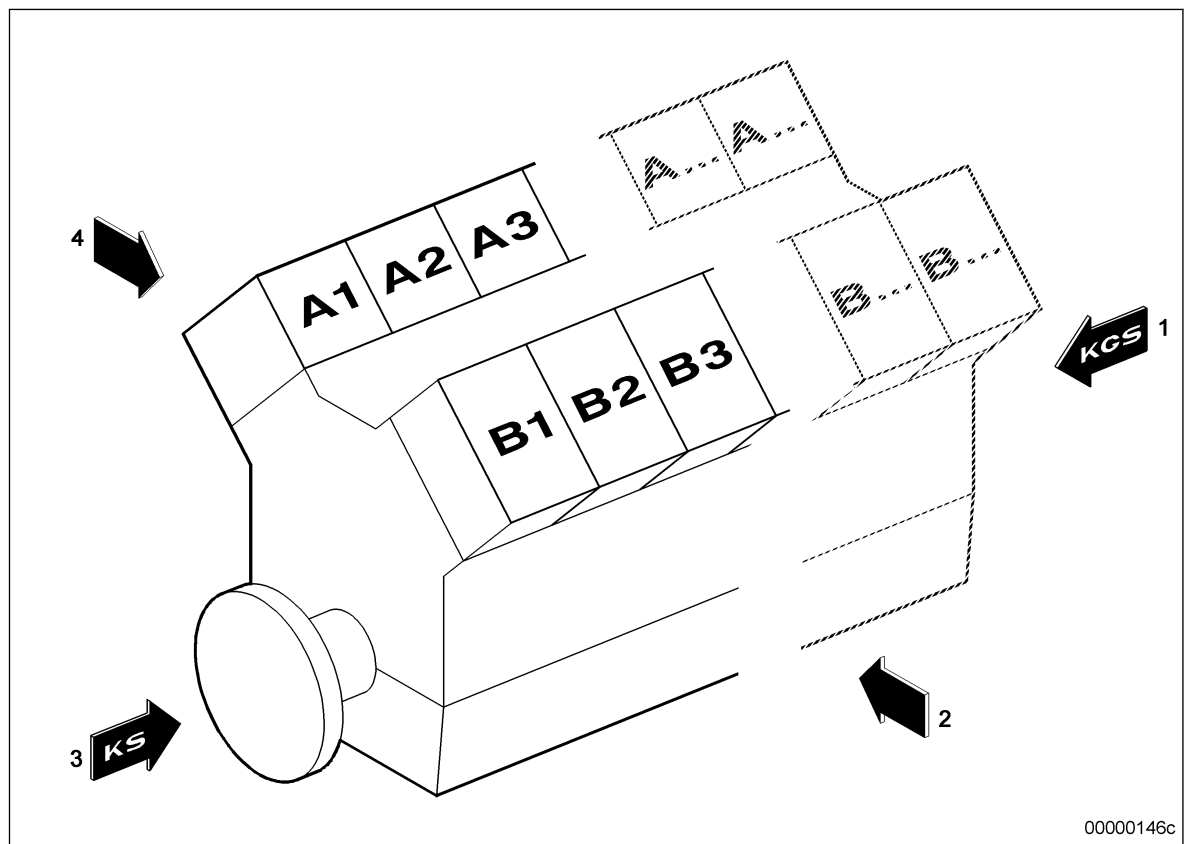
## 2 General Information

### 2.1 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS).

The cylinders of the left engine side are designated "A" and those of the right side "B" (as per DIN ISO 1204). The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end of the engine.

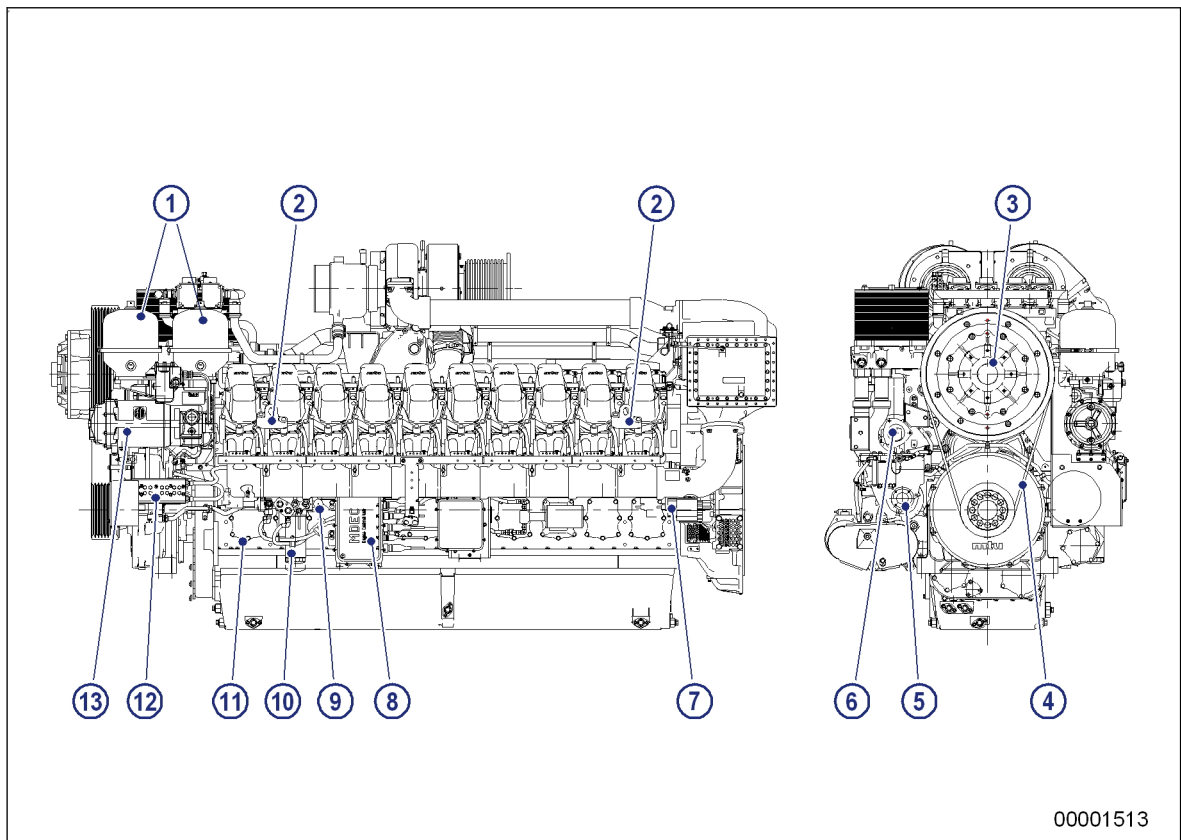
Other components are numbered in the same way, i.e. starting with No. 1 on driving end.



1 KGS = Free end  
2 Right engine side

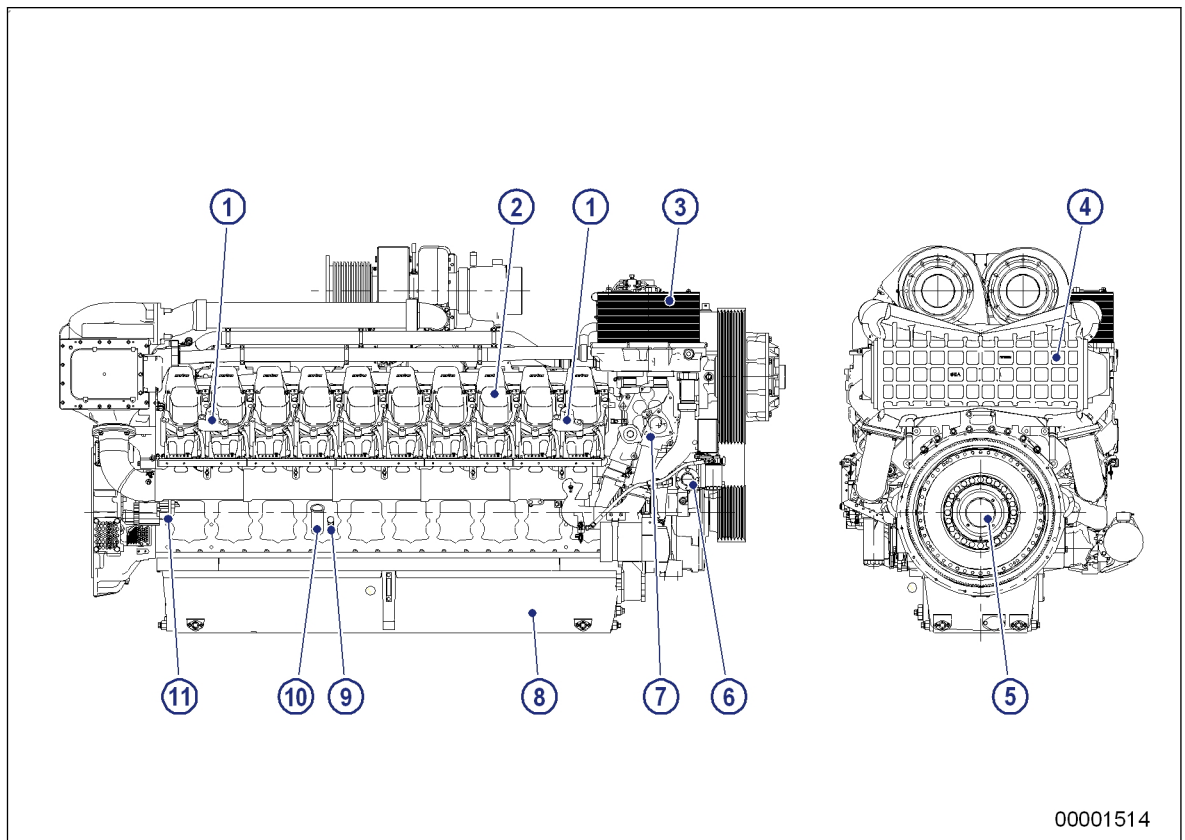
3 KS = Driving end  
4 Left engine side

## 2.2 Engine layout



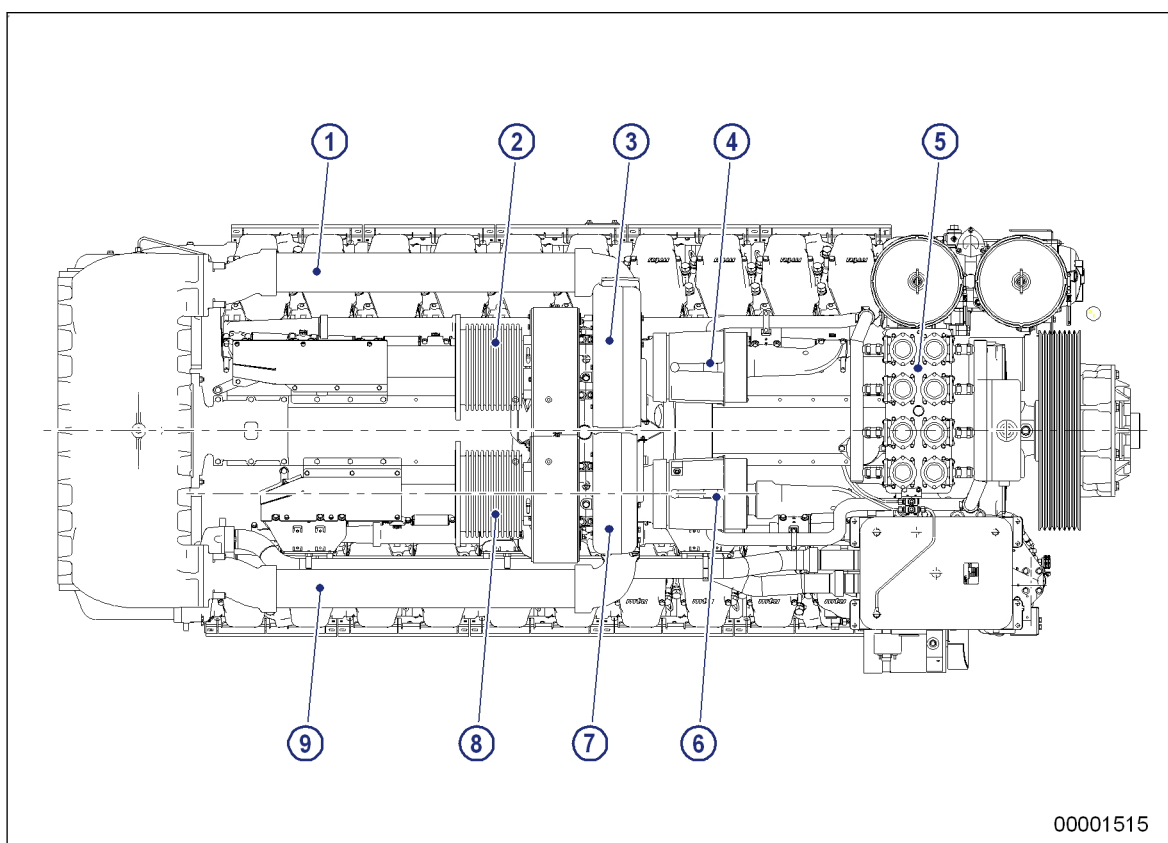
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|----------------------------|-------------------------------------|---|
| 1 Centrifugal oil filter   | 7 Starter (A side)                  | 11 Crankcase                            |
| 2 Engine lifting eye       | 8 Engine Control Unit ECU           | 12 HP fuel pump                         |
| 3 Fan drive                | 4                                   | 13 Engine oil filter (automatic filter) |
| 4 Drive belt               | 9 Fuel priming pump                 |   |
| 5 Charge-air coolant inlet | 10 Fuel filter (easy-change filter) |   |
| 6 Engine coolant outlet    |                                     |   |





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- |                                       |                             |                     |
|---------------------------------------|-----------------------------|---------------------|
| 1 Engine lifting eye                  | 4 Intercooler               | 8 Oil pan           |
| 2 Cylinder head cover / cylinder head | 5 Flywheel                  | 9 Oil dipstick      |
| 3 Oil heat exchanger                  | 6 Charge-air coolant outlet | 10 Oil filler neck  |
|                                       | 7 Engine coolant inlet      | 11 Starter (B side) |



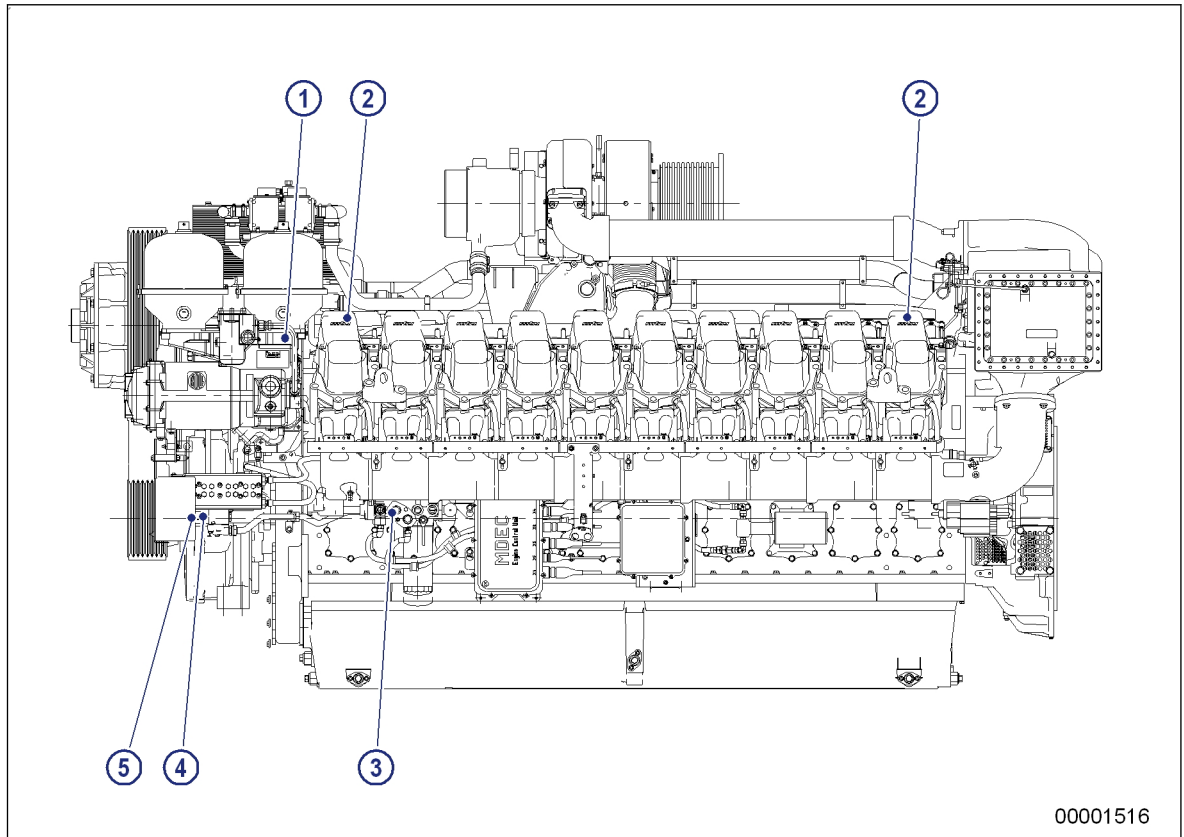
- |   |                                 |  |
|---|---------------------------------|--|
| 1 Air supply downstream of intercooler (A side) | 4 Combustion air inlet (A side) | 7 Exhaust turbocharger (B side)          |
| 2 Exhaust system connection (A side)            | 5 Crankcase breather            | 8 Exhaust system connection (B side)     |
| 3 Exhaust turbocharger (A side)                 | 6 Combustion air inlet (B side) | 9 Air supply before intercooler (B side) |

## Engine model designation

Key to the engine model designation 20V 4000 C22

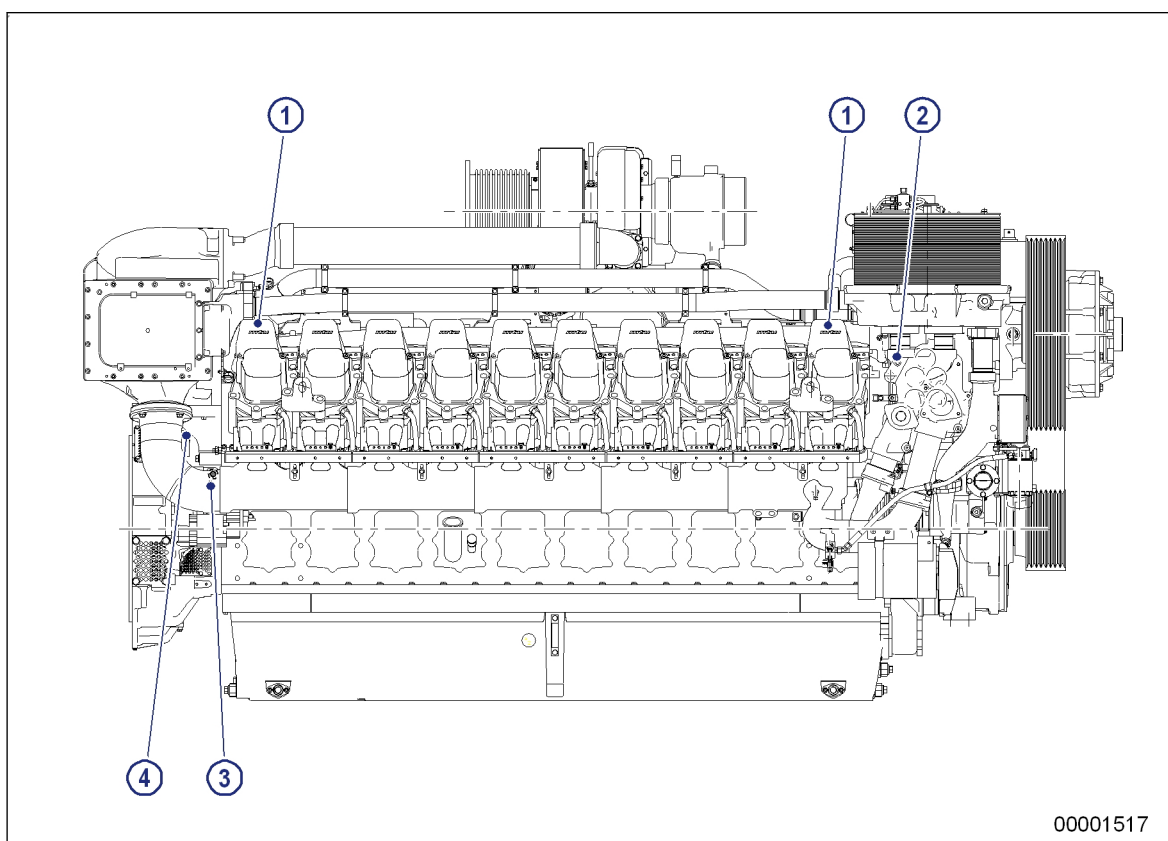
20	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
C	Application: Construction and Industrial, mobile
2	Application segment
2	Design index

## 2.3 Sensors, actuators and injectors – Overview



- |   |                             |
|---|-----------------------------|
| 1 B07 (T-Lube oil)                                | 3 B34 (P-Fuel after filter) |
| 2 Injectors Y39.1 to Y39.10<br>(A side cylinders) | 4 B48 (P-Fuel)              |
|   | 5 B33 (T-Fuel)              |

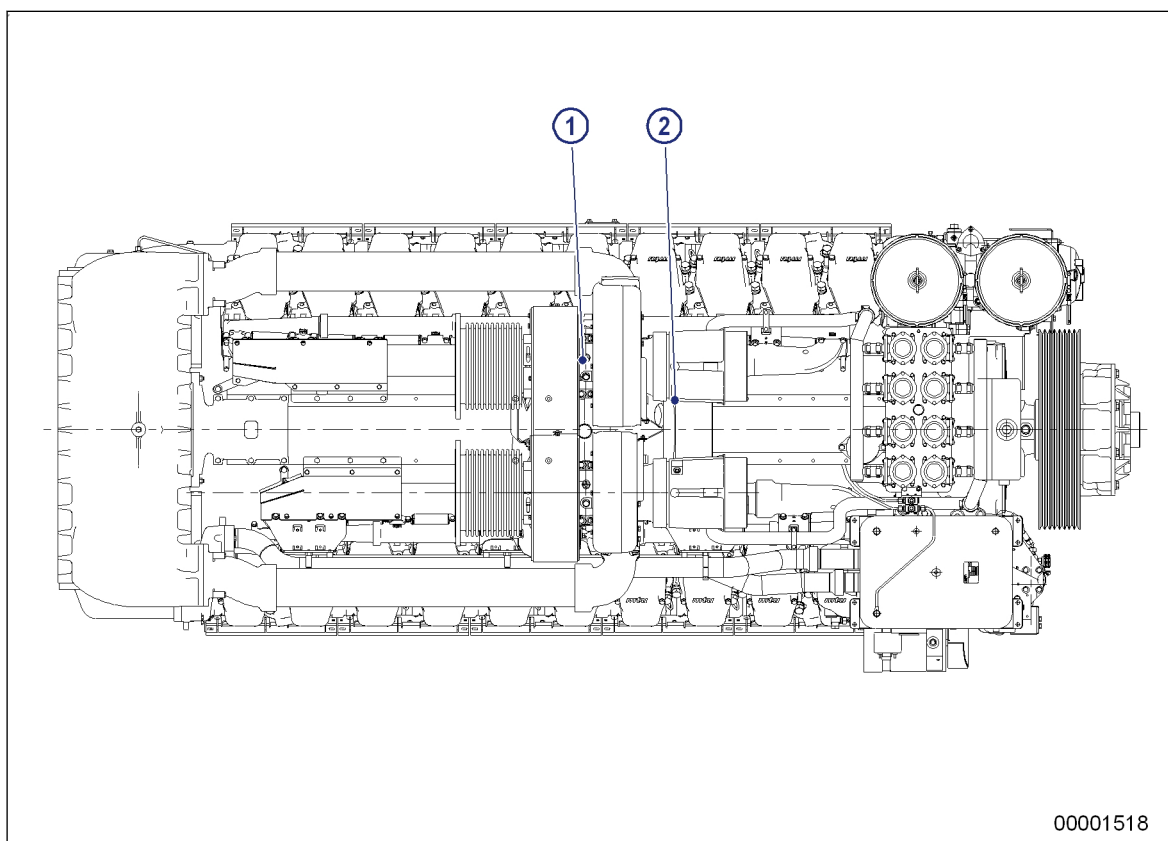
The injectors are underneath the cylinder head covers of the cylinder. Injector replacement and necessary activities (→ Page 78).



1 Injectors Y39.11 to  
Y39.20 (B side cylinders)

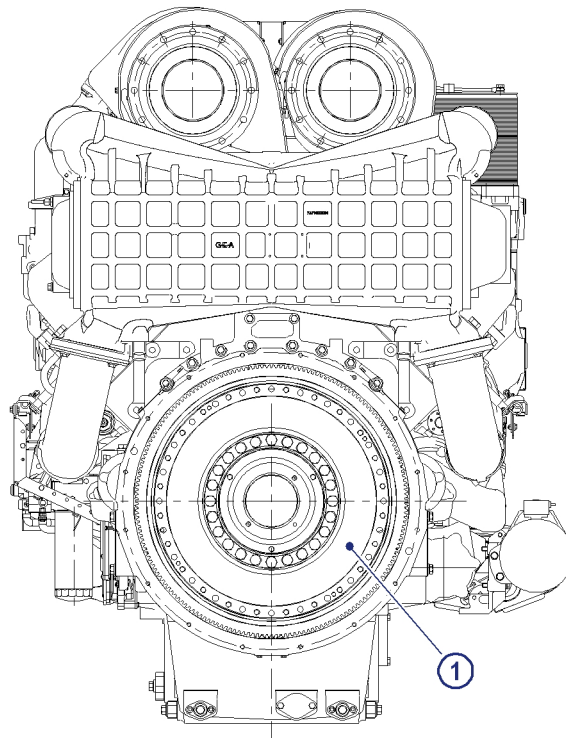
2 B16 (P-Coolant)  
3 B10 (P-Charge Air)

4 B09 (T-Charge Air)



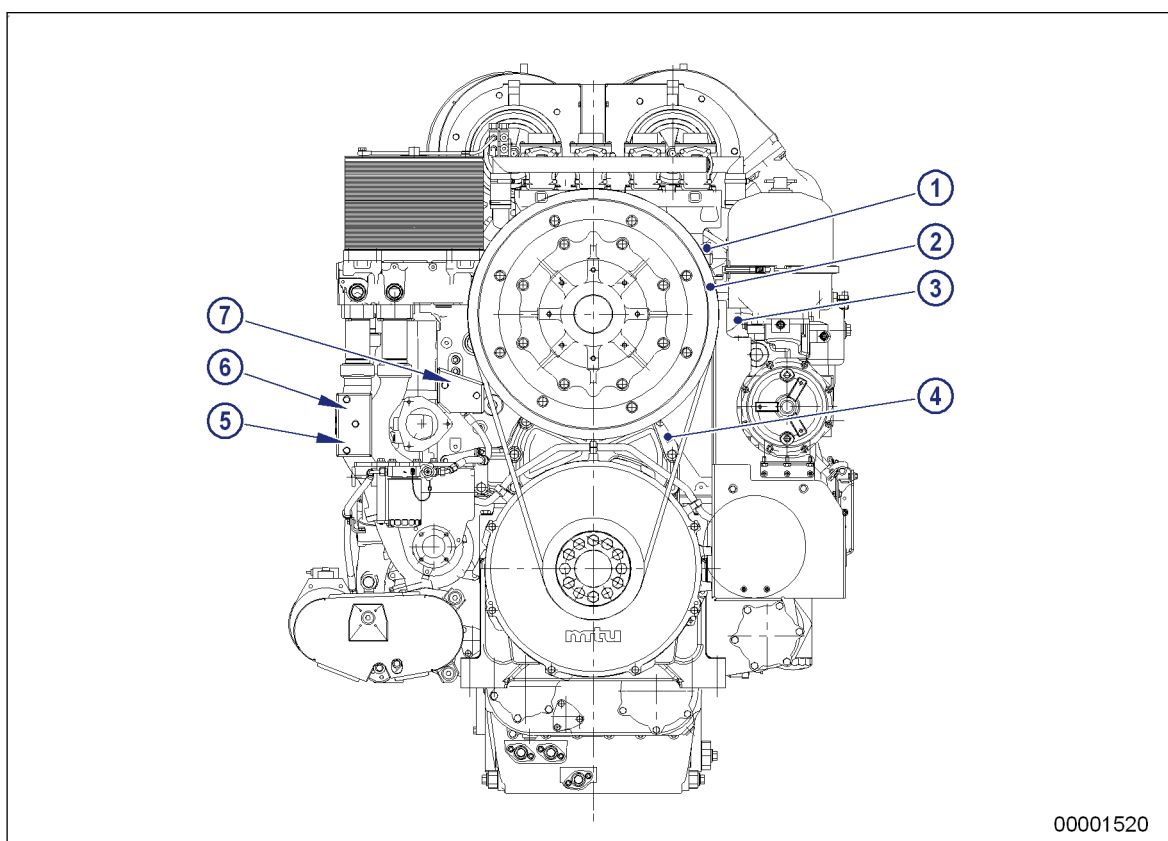
1 B44 (N-Turbocharger)

2 B03 (T-Intake Air)



00001519

1 B13 (N-Crankshaft)



- |   |                                    |                                    |
|---|------------------------------------|------------------------------------|
| 1 B50 (P-Crankcase)                     | 4 B01 (N-Camshaft)                 | 6 B26 (T-Coolant Intercool-<br>er) |
| 2 F25 (P-Lube Oil Diff.after<br>Filter) | 5 B43 (P-Coolant Intercool-<br>er) | 7 B06 (T-Coolant)                  |
| 3 B05 (P-Lube Oil)                      |                                    |                                    |

## 3 Technical Data

### 3.1 20V 4000 C22 engine data

Explanation:

- DL Ref. value: Continuous power (CP)
- BL Ref. value: Fuel stop power (FSP)
- A Design value
- G Guaranteed value
- R Guideline value
- L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
- N Not yet defined value
- Not applicable
- X Applicable

#### Reference Conditions

Engine model			20V 4000
Application group			5B
Intake air temperature		°C	25
Charge-air coolant temperature		°C	45
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			20V 4000
Engine rated speed	A	rpm	1800
Net brake power (without fan) (fuel stop power ISO 3046)	A	kW	2720

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			20V 4000
Intake air depression (new filter)	A	mbar	25
Intake air depression	L	mbar	50
Exhaust backpressure	A	mbar	30
Exhaust backpressure, max.	L	mbar	50
Fuel temperature at engine supply connection	R	°C	25

#### CONSUMPTION

Number of cylinders			20V 4000
Specific fuel consumption (be) 100% BL (+5%; EN 590; 42.8MJ/kg)	G	g/kWh	200
Lube oil consumption after 100 h operation, average (B = fuel consumption per hour)	R	% of B	0.3

## MODEL-RELATED DATA (basic design)

Number of cylinders			20V 4000
Number of cylinders			20
Cylinder configuration: V angle		degrees	90
Bore		mm	165
Stroke		mm	210
Cylinder displacement		liter	4.49
Total displacement		liter	89.81
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

## COMBUSTION AIR / EXHAUST GAS

Number of cylinders			20V 4000
Charge-air pressure before cylinder	R	bar abs	3.4
Exhaust temperature after turbocharger	R	°C	420

## COOLING SYSTEM (HT circuit)

Number of cylinders			20V 4000
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95
Coolant temperature after engine, alarm	R	°C	97
Coolant temperature after engine, shutdown	L	°C	99
Coolant antifreeze content, max. permissible	L	%	50
Coolant pump: inlet pressure, min.	L	bar	0.2
Coolant pump: inlet pressure, max.	L	bar	1.5
Thermostat: starts to open	R	°C	79
Thermostat: fully open	R	°C	92

## COOLING SYSTEM (LT circuit)

Number of cylinders			20V 4000
Coolant temperature (at engine outlet to cooling equipment)	R	°C	68
Coolant temperature before intercooler (with max. 40% antifreeze)	A	°C	45
Coolant temperature differential after/before intercooler, max.	L	°C	18
Coolant antifreeze content, max. permissible	L	%	50
Charge-air temperature after intercooler, max. admissible	L	°C	72
Thermostat: starts to open	R	°C	38
Thermostat: fully open	R	°C	51



## LUBE OIL SYSTEM

Number of cylinders			20V 4000
Lube oil operating temperature before engine, from	R	°C	86
Lube oil operating temp. before engine, to	R	°C	95
Lube oil operating pressure before engine (measuring block)	R	bar	5.3
Lube oil pressure before engine, alarm	R	bar	4.5
Lube oil pressure before engine, shutdown	L	bar	3.9

## FUEL SYSTEM

Number of cylinders			20V 4000
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	- 0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5
Fuel pressure before injection pump, from (H.P. pump)	R	bar	5.0
Fuel pressure before injection pump, to (H.P. pump)	R	bar	8.1
Fuel pressure before injection pump, min (H.P. pump)	R	bar	5.0

## GENERAL OPERATING DATA

Number of cylinders			20V 4000
Coolant temperature before full-load operation, recommended min. (for standby plants with coolant preheating at least preheating temperature)	R	°C	60

## INCLINATIONS STANDARD OIL SYSTEM (Ref.: waterline)

Number of cylinders			20V 4000
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degrees	10
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degrees	10
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degrees	22.5

## CAPACITIES

Number of cylinders			20V 4000
Engine coolant capacity (without cooling equipment)	R	liter	205
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	340
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	245

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			20V 4000
Engine weight, dry (basic engine configuration)	R	kg	9865

## ACOUSTICS

Number of cylinders			16
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	118
Engine surface noise with attenuated, BL, intake noise (filter) (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	108

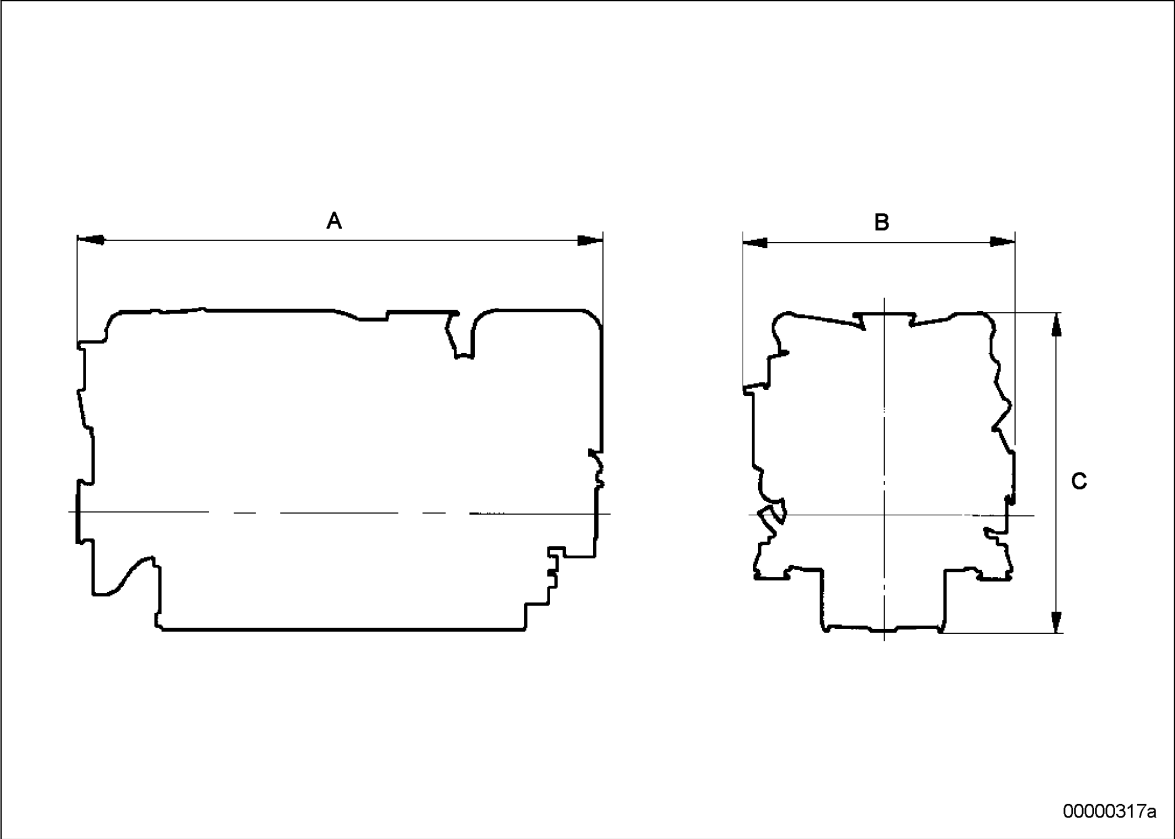
## 3.2 Firing order

### Firing order

Number of cylinders	Firing order
8V	A1-B4-A4-A2-B3-A3-B2-B1
12V	A1-B2-A5-B4-A3-B1-A6-B5-A2-B3-A4-B6
16 V	A1-A7-B4-B6-A4-B8-A2-A8-B3-B5-A3-A5-B2-A6-B1-B7
20 V	A1-B5-A8-B7-A5-B2-A7-B10-A2-B3-A10-B6-A3-B4-A6-B9-A4-B1-A9-B8

### 3.3 Main engine dimensions

#### Main engine dimensions



Length (A)	approx. 3630 mm
Width (B)	approx. 1450 mm
Height (C)	approx. 2252 mm

## 4 Operation

### 4.1 Putting the engine into operation after extended out-of-service periods (>3 months)

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### Putting into operation after long out-of-service periods (>3 months)

Item	Action
Engine	Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..).
Valve gear	Lubricate valve gear (→ Page 70).
Lube oil system	Check engine oil level (→ Page 96).
Fuel system	Vent (→ Page 85).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 106). Change charge-air coolant (→ Page 114).
Coolant circuit	Check engine coolant level (→ Page 105). Check charge-air coolant level (→ Page 113).
Coolant circuit	Preheat coolant with coolant preheating unit (if provided).
Engine governor	Check plug-in connections (→ Page 130).
Engine control system ECS	Switch ON.

## 4.2 Putting the engine into operation after scheduled out-of-service-period

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Startup

Item	Action
Lube oil system	Check engine oil level (→ Page 96).
Coolant circuit	Check engine coolant level (→ Page 105); Check charge-air coolant level (→ Page 113).
Coolant circuit	Preheat coolant with coolant preheating unit (if applicable).
Engine control system	Put into operation.

## 4.3 Engine – Start in manual mode

### Preconditions

- ☑ Engine with no load.
- ☑ External start interlock is not activated.

#### DANGER



Unguarded rotating and moving engine components.

#### **Risk of serious injury – danger to life!**

- Before barring or starting the engine, make sure that nobody is in the danger zone.

#### WARNING



Engine noise above 85 dB (A).

#### **Risk of damage to hearing!**

- Wear ear protectors.

### Preparation

Item	Measure
Operating mode switch (if applicable)	Switch to manual mode.
Coolant preheating unit (if applicable).	Switch on.

### Starting the engine

Item	Measure
Switch cabinet, operator station etc. (depending on manufacturer).	<p>If coolant temperature is</p> <ul style="list-style-type: none"><li>• &gt; 40 °C (with coolant preheating unit, if applicable)</li></ul> <p>press start button.</p> <ul style="list-style-type: none"><li>• Automatic starting sequence is executed</li><li>• Engine speed display instrument indicates increasing speed</li><li>• After the starting sequence is completed, engine is running at idle speed.</li></ul>

## 4.4 Operational checks

### DANGER



Unguarded rotating and moving engine components.

**Risk of serious injury – danger to life!**

- Take special care when working on a running engine.

### WARNING



Engine noise above 85 dB (A).

**Risk of damage to hearing!**

- Wear ear protectors.

### Operational checks

Item	Task	Task Code
Control and display panels	Check indicated operating parameters (speed, temperatures, pressures).	
Engine oil	Check engine oil level (→ Page 96).	W0500
Engine operation	Check engine visually for leaks and general condition;	W0501
	Check engine for abnormal running noises, exhaust color and vibrations (→ Page 41).	W0506
Battery-charging generator	Check battery-charging generator for contamination, clean as required (→ Page 121)	W0525
HP pump	Check relief bore (→ Page 77).	W0504
Fuel prefilter	Drain water and contaminants at drain cock on fuel prefilter (if fitted) (→ Page 87).	W0507
	Check reading on vacuum gauge of fuel prefilter (if fitted).	W0508
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 89).	W0502
HT cooling pump	Check relief bore (→ Page 110).	W0505
LT cooling pump	Check relief bore (→ Page 118).	W0505



# 4.5 Engine – Shutdown in manual mode

## Preconditions

- ☑ Engine is not under load
- ☑ Engine in manual mode

### CAUTION



Stopping the engine when it is running at full load causes extreme stress to the engine.

**Risk of overheating, damage to components!**

- Before stopping the engine, operate it at idle speed until operating temperatures decrease and stable values are indicated.

## Preparation

Item	Measure
Engine	Operate engine at idling speed for approx. 5 minutes.

## Shutting the engine down

Item	Measure
Switch cabinet, operator station etc. (depending on manufacturer)	<p>Press stop button.</p> <ul style="list-style-type: none"><li>• Automatic stopping sequence is executed.</li></ul>

## 4.6 After stopping the engine

### Preconditions

- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### After stopping the engine

Item	Task
Coolant circuit	Drain coolant (→ Page 107)(→ Page 115)if freezing temperatures are expected and: <ul style="list-style-type: none"><li>• the engine is to remain out of service for an extended period and coolant has no antifreeze additive;</li><li>• the coolant is not maintained at a suitable temperature;</li><li>• antifreeze concentration is 50 % and outside temperature is below -40°C.</li></ul>
Engine control system	Switch OFF.
Air intake and exhaust system	Out-of-service-period > 1 week: Seal engine's air and exhaust sides.  Out-of-service-period > 1 month: Preserve engine (→ MTU Fluids and Lubricants Specifications A001061/.. ).

## 4.7 Plant – Cleaning

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Operating voltage is not applied.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaner (Hakupur 312)	30390	1

#### WARNING



Compressed air

#### **Risk of injury!**

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

#### WARNING



Water jet.

#### **Risk of injury and scalding!**

- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

#### CAUTION



Excessive reaction time of cleaning agents on components.

#### **Damage to component!**

- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

Note: There is a risk of damaging sensors with compressed air.

### Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Prior to putting the cleaning unit into operation, read the Operating Instructions of the water/steam jet unit carefully and observe the safety precautions.
3. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
4. Carry out external cleaning as follows:
  - a) Remove coarse dirt.
  - b) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
  - c) Use the high-pressure jet to remove the loosened dirt.
  - d) During external cleaning of the plant with water/steam-jet units, the pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar. A minimum distance between spray nozzle and plant of 1 m must be observed. The temperature of the cleaning medium must not exceed 80°C.

# 5 Maintenance

## 5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Maintenance tasks	
W0500	Check engine oil level	(→ Page 96)
W0501	Visually inspect engine for leaks and general condition	–
W0502	Check intercooler drain (if applicable)	(→ Page 89)
W0503	Check signal ring position of service indicator	(→ Page 94)
W0504	Check relief bores of HP fuel pump	(→ Page 77)
W0505	Check relief bores of coolant pump(s)	(→ Page 110) (→ Page 118)
W0506	Check engine for abnormal running noises, exhaust color and vibrations	–
W0507	Drain water and dirt from fuel prefilter (if applicable)	(→ Page 88)
W0508	Check vacuum gage reading on fuel prefilter (if installed)	–
W0525	Check battery-charging generator for contamination, clean if necessary	(→ Page 121)
W1001	Replace fuel filter or fuel filter element	(→ Page 86)
W1002	Check valve clearance	(→ Page 71)
W1003	Check drive belt condition and tension, replace as necessary	(→ Page 119)
W1006	Replace fuel injectors	(→ Page 78)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if fitted), at every oil change, at the latest	(→ Page 103)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 59)
W1036	Replace coolant filter	(→ Page 112)
W1046	Crankcase breather: Replace filter or filter element	(→ Page 63)
W1047	Check and clean oil indicator filter	(→ Page 103)
W1164	Replace filter element and sealing ring depending on degree of contamination, when the limit (years) is reached, at the latest	–
W1209	Remove battery-charging generator and clean thoroughly with compressed air	(→ Page 120)
W1339	Replace grounding device with retainer (retainer only applicable to 20V)	–
W1463	Inspect general condition of the engine mounting (visual inspection)	–
W1481	Replace additional fuel filter or filter element	–

Table 1: Maintenance task reference table [QL1]

# 6 Troubleshooting

## 6.1 Troubleshooting

### Engine does not turn when starter is actuated

Component	Probable Cause	Task
Battery	Low or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check if cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter defective	Check if cable connections are properly secured, contact Service.
Engine wiring	Defective	Check (→ Page 128).
Engine/generator control system	Secure seating of assemblies or connectors not provided	Perform visual inspection (see manufacturer's documentation).
Engine governor	Plug-in connections are loose	Check plug-in connections (→ Page 130).
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

### Engine turns but does not fire

Component	Probable Cause	Task
Starter	Poor rotation by starter: Battery low or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Defective	Check (→ Page 128).
Fuel system	Not vented	Vent fuel system (→ Page 85).
Engine governor	Defective	Contact Service.

### Engine fires unevenly

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 78).
Engine wiring	Defective	Check (→ Page 128).
Fuel system	Not vented	Vent fuel system (→ Page 85).
Engine governor	Defective	Contact Service.

### Engine does not reach nominal speed

Component	Probable Cause	Task
Fuel supply	Fuel prefilter clogged	Replace.
	Fuel filter clogged	Replace (→ Page 86).
Air supply	Air filter clogged	Clean.
Fuel injection equipment	Injector defective	Replace (→ Page 78).

Component	Probable Cause	Task
Engine wiring	Defective	Check (→ Page 128).
Engine	Overloaded	Contact Service.

### Engine speed not steady

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 78).
Speed sensor	Defective	Contact Service.
Fuel system	Not vented	Vent fuel system (→ Page 85).
Engine governor	Defective	Contact Service.

### Charge-air temperature too high

Component	Probable Cause	Task
Engine coolant	Incorrect coolant concentration	Check (MTU test kit).
Intercooler	Contaminated	Contact Service.
Engine room	Air-intake temperature too high	Check fans and air supply / ventilation ducts.

### Charge air pressure too low

Component	Probable Cause	Task
Air supply	Air filter clogged	Clean.
Intercooler	Contaminated	Contact Service.
Exhaust turbocharger	Defective	Contact Service.

### Coolant leaks on intercooler

Component	Probable Cause	Task
Intercooler	Leaking, major coolant discharge	Contact Service.

### Exhaust gas black

Component	Probable Cause	Task
Air supply	Air filter clogged	Clean.
Fuel injection equipment	Injector defective	Replace (→ Page 78).
Engine	Overloaded	Contact Service.

### Exhaust gas blue

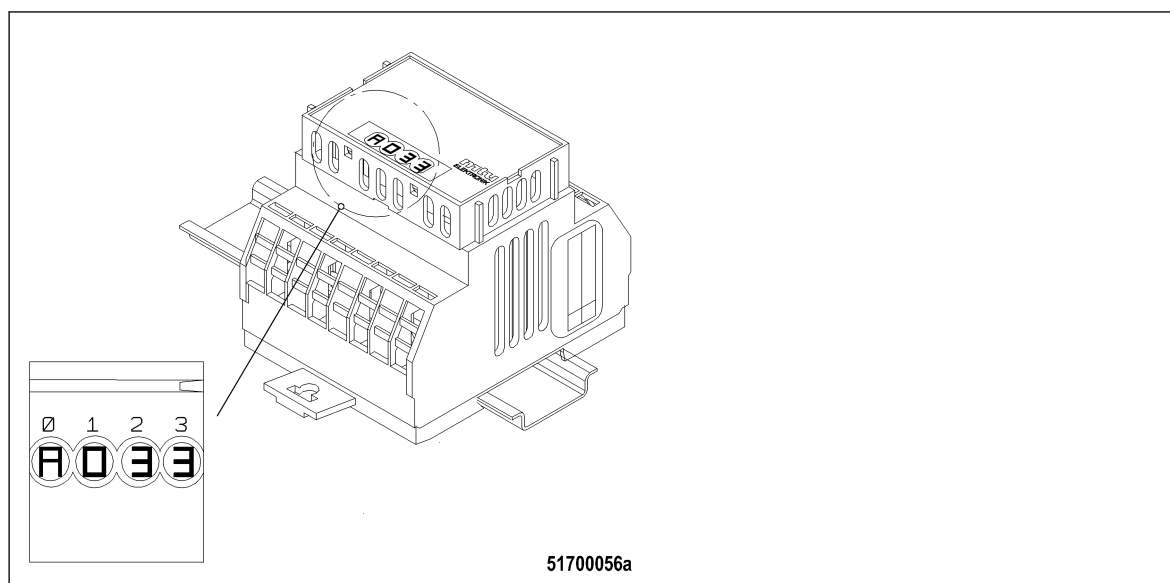
Component	Probable Cause	Task
Engine oil	Too much oil in engine	Drain engine oil (→ Page 97).
	Oil separator of crankcase breather contaminated	Replace (→ Page 63).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Defective	Contact Service.

## Exhaust gas white

Component	Probable Cause	Task
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Check fuel system on fuel prefilter. Drain fuel prefilter
Intercooler	Leaking	Contact Service.

## 6.2 ECU 4 alarms

Faults in the overall system are indicated as a four-digit code on the PIM display. The fault code numbers are generated by the ECU.



The four-digit code consists of one letter and three figures:

- The letter encodes when the fault occurred the last time:
  - A = currently present
  - B = within the last operating hour
  - C = one to four operating hours ago
  - D = four to twelve operating hours ago
 Alarms that occurred more than twelve hours ago are deleted automatically.
- The three figures encode the fault itself as listed in the table below.

Alarms can also be caused by defective sensors / actuators. If troubleshooting in accordance with the following table is not successful, contact Service to have the sensors / actuators checked and, if required, replaced.

Fault code	Alarm text	Meaning	Task
003	L1 T-FUEL	Fuel temperature too high (1st limit)	Reduce power.
004	L2 T-FUEL	Fuel temperature too high (2nd limit)	Reduce power.
005	L1 T-CHARGE AIR	Charge-air temperature too high (1st limit)	Reduce power.
006	L2 T-CHARGE AIR	Charge-air temperature too high (2nd limit)	Reduce power.
009	L1 T-INTERCOOLER	Charge-air coolant temperature too high (1st limit)	Reduce power.
010	L2 T-INTERCOOLER	Charge-air coolant temperature too high (2nd limit)	Reduce power.
015	L1 P-LUBE OIL	Lube-oil pressure too low (1st limit)	Check engine-oil level and top up, if required; (→ Page 96);



Fault code	Alarm text	Meaning	Task
016	L2 P-LUBE OIL	Lube-oil pressure too low (2nd limit) Automatic engine shut-down.	1. Check engine-oil level and top up, if required; (→ Page 96); 2. Try to re-start the engine (→ Page 35). 3. Contact Service.
023	L1 COOLANT LEVEL	Coolant level too low. Alarm appears together with No. 24.	Check coolant level in expansion tank.
024	L2 COOLANT LEVEL	Coolant level too low. Alarm appears together with No. 23.	Check coolant level in expansion tank.
025	L1 P-OILFILTER DIFF.	Oil filter pressure differential too high	Check oil filter.
030	ENGINE OVER-SPEED	Engine overspeed. Automatic engine shutdown.	1. Acknowledge alarm. 2. Try to re-start the engine (→ Page 35). 3. Contact Service.
031	ETC CHARGER 1 OVERSPEED 1	ETC 1 – overspeed (1st limit)	Contact Service:
032	ETC CHARGER 1 OVERSPEED 2	ETC 1– overspeed (2nd limit)	Contact Service.
036	ETC 2 CHARGER 2 OVERSPEED 1	ETC 2 – overspeed (1st limit)	Contact Service.
037	ETC 2 CHARGER 2 OVERSPEED 2	ETC 2 – overspeed (2nd limit)	Contact Service.
051	L1 T-LUBE OIL	Lube oil temperature too high (1st limit)	Reduce power.
052	L2 T-LUBE OIL	Lube oil temperature too high (2nd limit)	1. Reduce power. 2. If fault occurs repeatedly: Contact Service.
053	L1 T-INTAKE AIR	Intake air temperature too high (1st limit).	Reduce power.
054	L2 T-INTAKE AIR	Intake air temperature too high (2nd limit).	Reduce power.
057	L1 P-COOLANT	Coolant pressure too low (1st limit)	Check coolant circuit.
058	L2 P-COOLANT	Coolant pressure too low (2nd limit)	Check coolant circuit.
059	L1 P-INTERCOOLER	Charge-air coolant pressure too low (1st limit)	Check coolant circuit.
060	L2 P-INTERCOOLER	Charge-air coolant pressure too low (2nd limit)	Check coolant circuit.
063	L1 P-Crankcase	Crankcase pressure too high (1st limit)	Check oil separator. (→ Page 63)
064	L2 P-Crankcase	Crankcase pressure too high (2nd limit)	Replace oil separator.

Fault code	Alarm text	Meaning	Task
065	L1 P-FUEL	Fuel supply pressure too low (1st limit)	<ol style="list-style-type: none"> <li>1. Check fuel lines for leaks; repair defective lines.</li> <li>2. Clean fuel prefilter</li> <li>3. Flush fuel prefilter</li> <li>4. Replace filter element of fuel prefilter.</li> <li>5. Fuel filter replacement (→ Page 86).</li> <li>6. If fault is not rectified: Contact Service.</li> </ol>
066	L2 P-FUEL	Fuel supply pressure too low (2nd limit)	<ol style="list-style-type: none"> <li>1. Check fuel lines for leaks; repair defective lines.</li> <li>2. Clean fuel prefilter</li> <li>3. Flush fuel prefilter</li> <li>4. Replace filter element of fuel prefilter.</li> <li>5. Fuel filter replacement (→ Page 86).</li> <li>6. If fault is not rectified: Contact Service.</li> </ol>
067	L1 T-COOLANT	Coolant temperature too high (1st limit). Warning	Reduce power.
068	L2 T-COOLANT	<p>Coolant temperature too high (2nd limit).</p> <p>Automatic engine shut-down.</p>	<ol style="list-style-type: none"> <li>1. Allow the engine to cool down.</li> <li>2. Check coolant cooler (elements etc.) and clean contaminated parts (see manufacturer's documentation).</li> <li>3. Re-start the engine (→ Page 35).</li> <li>4. If fault occurs repeatedly: Contact Service.</li> </ol>
081	RAIL LEAKAGE	HP fuel system leaking, system contains air	Contact Service.
082	RAIL PRESSURE HIGH	<p>Pressure in HP fuel system exceeds specified value;</p> <p>Solenoid valve of HP fuel control block jamming or wiring to solenoid valve defective</p>	Contact Service.
083	RAIL PRESSURE LOW	<p>Pressure in HP fuel system lower than the specified value;</p> <p>HP fuel control block defective or system leaking.</p> <p>NOTE:</p> <p>With very large generators having a run-out time of more than &gt; 20 sec this alarm is not a relevant fault.</p>	Contact Service.
087	L1 LEV. WATER IN FUEL	Water level in fuel prefilter too high	Check fuel prefilter

Fault code	Alarm text	Meaning	Task
089	ENGINE SPEED LOW	Engine speed lower than 200 rpm;  Automatic engine shut-down.	Re-start the engine (→ Page 35).
090	IDLE SPEED LOW	Idle speed not reached within a specified period;  Termination of starting procedure.	Note further alarms.
091	RUN UP SPEED LOW	Run-up speed not reached within a specified period;  Termination of starting procedure.	Note further alarms.
092	START SPEED LOW	Starter speed not reached within a specified period;  Termination of starting procedure.	Note further alarms.
093	PREHEAT TEMP. LIMIT2	Coolant preheating temperature too low during starting (2nd limit);  Termination of starting procedure (depending on project design).	Check preheating pump / preheating system (see manufacturer's documentation).
094	PREHEAT TEMP. LIMIT1	Coolant preheating temperature too low during starting (1st limit)	Check preheating pump / preheating system (see manufacturer's documentation).
100	EDM NOT VALID	Check sum error of measuring-point data in EDM	If fault occurs repeatedly: Contact Service.
101	IDM NOT VALID	Check sum error of measuring-point data in IDM	If fault occurs repeatedly: Contact Service.
102	INVALID FUEL CONS 1	Check sum error of accumulated fuel consumption data in EDM (redundant data record 1)	Contact Service.
103	INVALID FUEL CONS 2	Check sum error of accumulated fuel consumption data in EDM (redundant data record 2)	Contact Service.
104	OP HOURS1 NOT VALID	Check sum error of hour meter data in EDM	If fault occurs repeatedly: Contact Service.
105	OP HOURS2 NOT VALID	Check sum error of hour meter data in IDM	If fault occurs repeatedly: Contact Service.
106	ERR REC1 NOT VALID	Check sum error of fault memory in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
107	ERR REC2 NOT VALID	Check sum error of fault memory in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.
118	L1 SUPPLY VOLT. LOW	Supply voltage too low (1st limit)	Check ECU supply voltage.

Fault code	Alarm text	Meaning	Task
119	L2 SUPPLY VOLT. LOW	Supply voltage too low (2nd limit)	Check ECU supply voltage.
120	L1 SUPPLY VOLT. HIGH	Supply voltage too high (1st limit)	Check ECU supply voltage.
121	L2 SUPPLY VOLT. HIGH	Supply voltage too high (2nd limit); Automatic engine shut-down (depending on project design).	Check ECU supply voltage. If engine was stopped: Start engine (→ Page 35).
122	L1 T-ELECTRONIC	Temperature in ECU housing too high (1st limit)	1. Improve engine room ventilation. 2. Reduce engine power.
134	15V POS ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
136	15V NEG ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
137	L1 5V BUFFER TEST	Power supply for pressure sensors defective	1. Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
138	SENSORPOWER-DEFECT	Power supply for pressure sensors defective	1. Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
139	L1 TE BUFFER TEST	Internal electronic fault (temperature sensors)	Contact Service.
140	TE BUF. ECU DEFECT	Internal electronic fault (temperature sensors)	Contact Service.
142	BANK1 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.
144	BANK2 ECU DEFECT	Internal electronic fault; Engine does not start.	Contact Service.
145	15V_GOOD ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
146	L1 AD-TEST1 SUPPLY	A/D-converter supply voltage too low.	Contact Service.

Fault code	Alarm text	Meaning	Task
147	AD-TEST1 ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
148	L1 AD-TEST2 SUPPLY	A/D-converter supply voltage too low.	Contact Service.
149	AD-TEST2 ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
150	L1 AD-TEST3 SUPPLY	A/D-converter supply voltage too low.	Contact Service.
151	AD-TEST3 ECU DEFECT	Electronic equipment defective; Automatic engine shut-down.	Contact Service.
170	MI MODULE FAIL	Module in maintenance predictor either defective or missing.	Contact Service.
171	MI NOT ACTIVE	Maintenance predictor no more activated	Contact Service.
173	MODULE WRITE LIMIT	EEPROM write limit reached.	Contact Service.
180	CAN1 NODE LOST	At least one device not detected on Default CAN bus.	1. Check wiring (CAN bus). 2. Contact Service.
181	CAN2 NODE LOST	At least one device not detected on Redundant CAN bus.	1. Check wiring (CAN bus). 2. Contact Service.
183	CAN NO PU-DATA	Error during loading of CAN project design data into ECU.	Contact Service.
184	CAN PU-DATA EE-FAIL	Error during project design data download in EEPROMs.	Contact Service.
185	CAN LESS MAILBOXES	Error during CAN initialization.	Contact Service.
186	CAN1 BUS OFF	Severe fault on Default CAN bus; automatic change-over to Redundant CAN bus	Contact Service.
187	CAN1 ERROR PASSIVE	Light fault on Default CAN bus (e.g. short-time overload)	(none)
188	CAN2 BUS OFF	Severe fault on Redundant CAN bus; Automatic change-over to Default CAN bus.	Contact Service.

Fault code	Alarm text	Meaning	Task
189	CAN2 ERROR PASSIVE	Light fault on Redundant CAN bus (e.g. short-time overload)	(none)
201	SD T-COOLANT	Sensor defect (coolant temperature)	1. Check wiring. 2. Contact Service.
202	SD T-FUEL	Sensor defect (fuel temperature)	1. Check wiring. 2. Contact Service.
203	SD T-CHARGE AIR	Sensor defect (charge-air temperature)	1. Check wiring. 2. Contact Service.
205	SD T-COOLANT INTERC.	Sensor defect (charge-air coolant temperature)	1. Check wiring. 2. Contact Service.
208	SD P-CHARGE AIR	Sensor defect (charge-air pressure)	1. Check wiring. 2. Contact Service.
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	1. Check wiring. 2. Contact Service.
212	SD P-COOLANT	Sensor defect (coolant pressure)	1. Check wiring. 2. Contact Service.
213	SD P-COOLANT INTERC.	Sensor defect (intercooler coolant pressure)	1. Check wiring. 2. Contact Service.
214	SD P-CRANKCASE	Sensor defect (crankcase pressure)	1. Check wiring. 2. Contact Service.
215	SD P-RAIL FUEL	Sensor defect (common rail pressure); HP controller in emergency mode.	1. Check wiring. 2. Contact Service.
216	SD T-LUBE OIL	Sensor defect (lube oil temperature)	1. Check wiring. 2. Contact Service.
219	SD T-INTAKE AIR	Sensor defect (intake-air temperature)	1. Check wiring. 2. Contact Service.
220	SD COOLANT LEVEL	Sensor defect (coolant level)	1. Check wiring. 2. Contact Service.
221	SD P-OILFILTER DIFF	Sensor defect (lube oil pressure differential)	1. Check wiring. 2. Contact Service.
226	SD WATER IN FUEL	Sensor defect (water in fuel prefilter)	1. Check wiring. 2. Contact Service.
229	SD ENG.SPEED SENSORS	Sensor defect (crankshaft speed) and sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
230	SD CRANKSHAFT SPEED	Sensor defect (crankshaft speed)	1. Check wiring. 2. Contact Service.
231	SD CAMSHAFT SPEED	Sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
232	SD ETC SPEED 11	Sensor defect (turbocharger speed)	1. Check wiring. 2. Contact Service.
240	SD P-FUEL	Sensor defect (fuel pressure)	1. Check wiring. 2. Contact Service.
245	SD POWER SUPPLY	Sensor defect (ECU operating voltage)	Contact Service.

Fault code	Alarm text	Meaning	Task
246	SD T-ELECTRONIC	Sensor defect (temperature in ECU)	Contact Service.
266	SD SPEED DEMAND AN.	Sensor defect (analog speed demand)	1. Check speed transmitter 2. Check wiring. 3. Contact Service.
301	TIMING CYLINDER A1	Injection timing fault cylinder A1	If fault occurs repeatedly: Contact Service.
302	TIMING CYLINDER A2	Injection timing fault cylinder A2	If fault occurs repeatedly: Contact Service.
303	TIMING CYLINDER A3	Injection timing fault cylinder A3	If fault occurs repeatedly: Contact Service.
304	TIMING CYLINDER A4	Injection timing fault cylinder A4	If fault occurs repeatedly: Contact Service.
305	TIMING CYLINDER A5	Injection timing fault cylinder A5	If fault occurs repeatedly: Contact Service.
306	TIMING CYLINDER A6	Injection timing fault cylinder A6	If fault occurs repeatedly: Contact Service.
307	TIMING CYLINDER A7	Injection timing fault cylinder A7	If fault occurs repeatedly: Contact Service.
308	TIMING CYLINDER A8	Injection timing fault cylinder A8	If fault occurs repeatedly: Contact Service.
309	TIMING CYLINDER A9	Injection timing fault cylinder A9	If fault occurs repeatedly: Contact Service.
310	TIMING CYLINDER A10	Injection timing fault cylinder A10	If fault occurs repeatedly: Contact Service.
311	TIMING CYLINDER B1	Injection timing fault cylinder B1	If fault occurs repeatedly: Contact Service.
312	TIMING CYLINDER B2	Injection timing fault cylinder B2	If fault occurs repeatedly: Contact Service.
313	TIMING CYLINDER B3	Injection timing fault cylinder B3	If fault occurs repeatedly: Contact Service.
314	TIMING CYLINDER B4	Injection timing fault cylinder B4	If fault occurs repeatedly: Contact Service.
315	TIMING CYLINDER B5	Injection timing fault cylinder B5	If fault occurs repeatedly: Contact Service.
316	TIMING CYLINDER B6	Injection timing fault cylinder B6	If fault occurs repeatedly: Contact Service.
317	TIMING CYLINDER B7	Injection timing fault cylinder B7	If fault occurs repeatedly: Contact Service.
318	TIMING CYLINDER B8	Injection timing fault cylinder B8	If fault occurs repeatedly: Contact Service.
319	TIMING CYLINDER B9	Injection timing fault cylinder B9	If fault occurs repeatedly: Contact Service.
320	TIMING CYLINDER B10	Injection timing fault cylinder B10	If fault occurs repeatedly: Contact Service.
321	WIRING CYLINDER A1	Faulty wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
322	WIRING CYLINDER A2	Faulty wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
323	WIRING CYLINDER A3	Faulty wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
324	WIRING CYLINDER A4	Faulty wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
325	WIRING CYLINDER A5	Faulty wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
326	WIRING CYLINDER A6	Faulty wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.
327	WIRING CYLINDER A7	Faulty wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.
328	WIRING CYLINDER A8	Faulty wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
329	WIRING CYLINDER A9	Faulty wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.
330	WIRING CYLINDER A10	Faulty wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring 2. Contact Service:
331	WIRING CYLINDER B1	Faulty wiring to solenoid valve cylinder B1; Misfiring	1. Check wiring. 2. Contact Service.
332	WIRING CYLINDER B2	Faulty wiring to solenoid valve cylinder B2; Misfiring	1. Check wiring. 2. Contact Service.
333	WIRING CYLINDER B3	Faulty wiring to solenoid valve cylinder B3; Misfiring	1. Check wiring. 2. Contact Service.
334	WIRING CYLINDER B4	Faulty wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
335	WIRING CYLINDER B5	Faulty wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
336	WIRING CYLINDER B6	Faulty wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.



Fault code	Alarm text	Meaning	Task
337	WIRING CYLINDER B7	Faulty wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
338	WIRING CYLINDER B8	Faulty wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
339	WIRING CYLINDER B9	Faulty wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring. 2. Contact Service.
340	WIRING CYLINDER B10	Faulty wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring. 2. Contact Service.
341	OPEN_LOAD CYL. A1	Disconnection in wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.
342	OPEN_LOAD CYL. A2	Disconnection in wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
343	OPEN_LOAD CYL. A3	Disconnection in wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
344	OPEN_LOAD CYL. A4	Disconnection in wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
345	OPEN_LOAD CYL. A5	Disconnection in wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
346	OPEN_LOAD CYL. A6	Disconnection in wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.
347	OPEN_LOAD CYL. A7	Disconnection in wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.
348	OPEN_LOAD CYL. A8	Disconnection in wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
349	OPEN_LOAD CYL. A9	Disconnection in wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.
350	OPEN_LOAD CYL. A10	Disconnection in wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
351	OPEN_LOAD CYL. B1	Disconnection in wiring to solenoid valve cylinder B1;  Misfiring	1. Check wiring. 2. Contact Service.
352	OPEN_LOAD CYL. B2	Disconnection in wiring to solenoid valve cylinder B2;  Misfiring	1. Check wiring. 2. Contact Service.
353	OPEN_LOAD CYL. B3	Disconnection in wiring to solenoid valve cylinder B3;  Misfiring	1. Check wiring. 2. Contact Service.
354	OPEN_LOAD CYL. B4	Disconnection in wiring to solenoid valve cylinder B4;  Misfiring	1. Check wiring. 2. Contact Service.
355	OPEN_LOAD CYL. B5	Disconnection in wiring to solenoid valve cylinder B5;  Misfiring	1. Check wiring. 2. Contact Service.
356	OPEN_LOAD CYL. B6	Disconnection in wiring to solenoid valve cylinder B6;  Misfiring	1. Check wiring. 2. Contact Service.
357	OPEN_LOAD CYL. B7	Disconnection in wiring to solenoid valve cylinder B7;  Misfiring	1. Check wiring. 2. Contact Service.
358	OPEN_LOAD CYL. B8	Disconnection in wiring to solenoid valve cylinder B8;  Misfiring	1. Check wiring. 2. Contact Service.
359	OPEN_LOAD CYL. B9	Disconnection in wiring to solenoid valve cylinder B9;  Misfiring	1. Check wiring 2. Contact Service.
360	OPEN_LOAD CYL. B10	Disconnection in wiring to solenoid valve cylinder B10;  Misfiring	1. Check wiring 2. Contact Service:
361	POWER STAGE FAIL 1	Defect in ECU (solenoid valve power stage)	Contact Service.
362	POWER STAGE FAIL 2	Defect in ECU (solenoid valve power stage)	Contact Service.
363	STOP POWER STAGE 1	Solenoid valve or wiring or ECU defective  Automatic engine shut- down.	1. Check wiring. 2. Try to re-start the engine (→ Page 35). 3. Contact Service.
364	STOP POWER STAGE 2	Solenoid valve or wiring or ECU defective  Automatic engine shut- down.	1. Check wiring. 2. Try to re-start the engine (→ Page 35). 3. Contact Service.

Fault code	Alarm text	Meaning	Task
365	STOP SOLENOID-WIRING	Solenoid-valve wiring fault; Automatic engine shut-down.	1. Check wiring. 2. Try to re-start the engine (→ Page 35). 3. Contact Service.
381	TRAN.OUT1 PLANT DEF	Binary transistor output plant 1 defective	Contact Service.
382	TRAN.OUT2 PLANT DEF	Binary transistor output plant 2 defective	Contact Service.
383	TRAN.OUT3 PLANT DEF	Binary transistor output plant 3 defective	Contact Service.
384	TRAN.OUT4 PLANT DEF	Binary transistor output plant 4 defective	Contact Service.
385	TRAN.OUT 5 PLANT DEF	Binary transistor output plant 5 defective	Contact Service.
386	TRAN.OUT 6 PLANT DEF	Binary transistor output plant 6 defective	Contact Service.

# 7 Task Description

## 7.1 Engine

### 7.1.1 Engine – Barring manually

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring device	F6555766	1
Barring device	F6783293	1
Adapter	F6558528	1
Ratchet	F30006212	1

DANGER



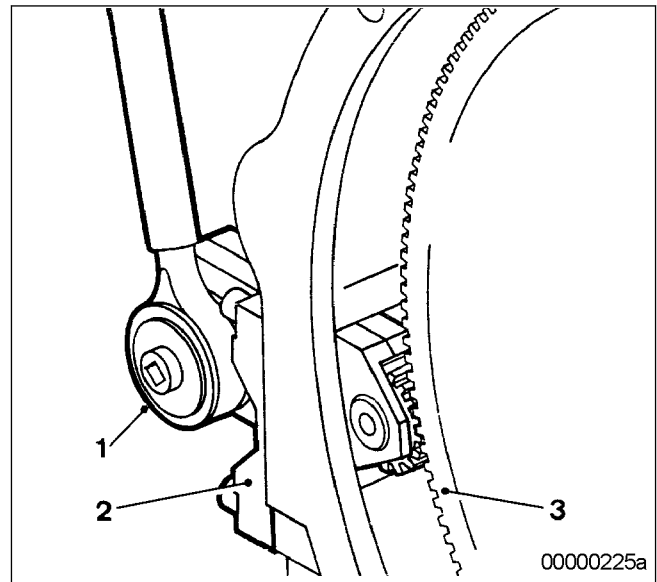
Unguarded rotating and moving engine components.

**Risk of serious injury – Danger to life!**

- Before barring the engine, ensure that nobody is in the danger zone.

#### Barring engine manually (lateral installation)

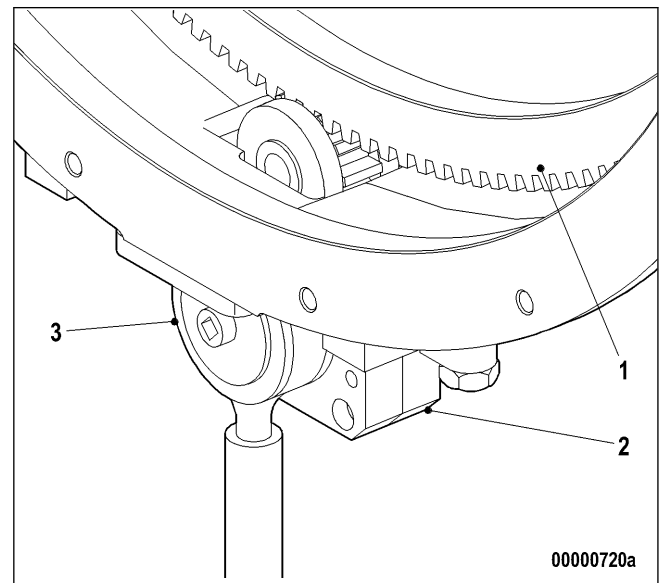
1. Remove guard plate.
2. Engage barring device (2) in ring gear (3) and install on flywheel housing.
  - Use barring device F6555766.
3. Set ratchet (1) onto barring device (2).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
5. For barring device removal follow reverse sequence of working steps.



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### Barring engine manually (installation on lower side)

1. Remove grounding device or guard plate.
2. Engage barring device (2) with ring gear (1) and mount on flywheel housing.
  - For 12/16V engines, use barring device F6555766 with adapter F6558528.
  - For 20V engines, use barring device F6783293.
3. Set ratchet (3) onto barring device (2).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
5. For barring device removal follow reverse sequence of working steps.



## 7.1.2 Engine – Barring with starting system

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

#### DANGER



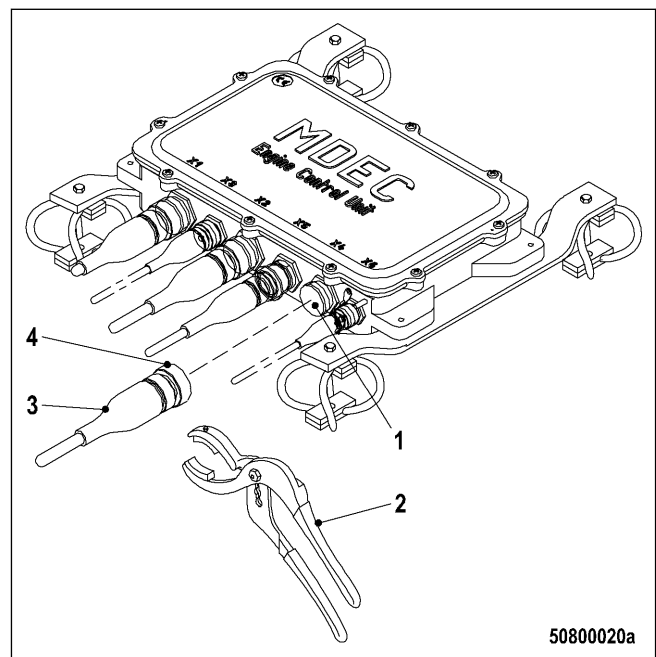
Unguarded rotating and moving engine components.

#### **Risk of serious injury – danger to life!**

- before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

### Engine – Barring with starting system

1. Disengage the bayonet coupling (4) of connector X4 with connector pliers (2) and withdraw connector (3) from engine governor.
2. Bar engine in unloaded condition: Press START button.
3. Let the crankshaft rotate until oil pressure is indicated.
4. Engine start is automatically interrupted when specified starting period is expired. If necessary, re-start the engine after approx. 20 seconds.
5. Plug connector X4 (3) and use connector pliers (2) to secure the bayonet coupling (4) by turning it clockwise until it latches into place.



## 7.2 Cylinder Liner

### 7.2.1 Cylinder liner – Endoscopic examination

#### Preconditions

- ☑ Engine is stopped and starting disabled

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Endoscope	Y20097353	

#### Preparatory steps

1. Remove cylinder head cover (→ Page 76).
2. Remove injector (→ Page 79).

#### Positioning crankshaft at BDC

1. Using barring device, turn crankshaft until crankshaft journal of the cylinder to be tested has reached BDC.
2. Insert endoscope into cylinder liner through injector seat.

#### Cylinder liner endoscopic examination

Findings	Measure
<ul style="list-style-type: none"><li>• Thin carbon coating on carbon scraper ring</li><li>• Slight localized additive deposits at top edge</li><li>• Localized smooth areas at bottom edge</li><li>• Carbon deposits on entire circumference between top piston ring and bottom edge of carbon scraper ring</li><li>• First signs of marks left by top piston ring</li><li>• Bright mark on entire circumference</li><li>• Faultless, even honing pattern</li><li>• First signs of marks left by lower cooling bores</li><li>• Running pattern seems darker</li></ul>	No action required
<ul style="list-style-type: none"><li>• Dark areas with even or varying degrees of discoloration</li><li>• Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area</li><li>• Dark areas in the upper section of the cooling bore, remaining circumference cannot be faulted</li><li>• Piston rings cannot be faulted</li></ul>	Further endoscopic examination required as part of maintenance work
<ul style="list-style-type: none"><li>• On the entire circumference, apart from light areas of discoloration (do not impair operation) clearly darker stripes that start at the top piston ring</li><li>• Heat discoloration in the direction of stroke and honing pattern damage</li><li>• Heat discoloration of piston rings</li></ul>	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 61).
3. Depending on findings:
  - Do not take any action or
  - carry out a further endoscopic examination as part of maintenance work or
  - contact Service; cylinder liner must be replaced.

## Final steps

1. Install injector (→ Page 79).
2. Install cylinder head cover (→ Page 76).



## 7.2.2 Instructions and comments on endoscopic and visual examination of cylinder liners

### Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

Findings	Measure
Light scoring	<p>Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly exhibit such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail.</p> <p>Findings not critical.</p>
Single scores	<p>Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the honing pattern in the direction of stroke.</p> <p>Findings not critical.</p>
Scored area	<p>These areas consist of scores of different lengths and depths next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis.</p> <p>Findings not critical.</p>
Smoothened area	<p>Smoothened areas are changes to the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface.</p> <p>Findings not critical.</p>
Polished area	<p>Polished areas are on the running surface and show local removal of the honing pattern. Grooves from the honing process are not visible any more.</p> <p>New cylinder liners must be fitted in the following cases</p> <p>Polished area:</p> <ul style="list-style-type: none"> <li>covers more than 20% of the entire piston running surface,</li> <li>covers more than 30° of the circumference and extends over more than 50% of piston stroke,</li> <li>is wider than 15 mm over the entire piston stroke.</li> </ul>
Discoloration	<p>This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted.</p> <p>Findings not critical.</p>
Corrosion fields / spots	<p>Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom.</p> <p>This corrosion is not critical unless there is corrosion pitting.</p>
Black lines	<p>Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern.</p> <p>Cylinders with a number of black lines around the running surface have limited service life and should be replaced.</p>

Findings	Measure
Discolorations (Heat)	<p>These are caused by a disturbance in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies.</p> <p>Liners with heat discoloration starting in the TDC-ring 1 have to be replaced.</p>
Seizures, Seizure marks	<p>Seizure marks are of irregular circumferential length and depth. Can be caused by either the piston skirt or the piston crown. Material deposits on the liner (smears) show heavy discoloration and scoring.</p> <p>Replace liner.</p>

### Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. Thorough investigation and compliance with the above evaluation criteria allows a definite evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

## 7.3 Crankcase Breather

### 7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6 to 50 Nm	F30027336	1
Ratchet	F30027340	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
Seal	(→ Spare Parts Catalog)	

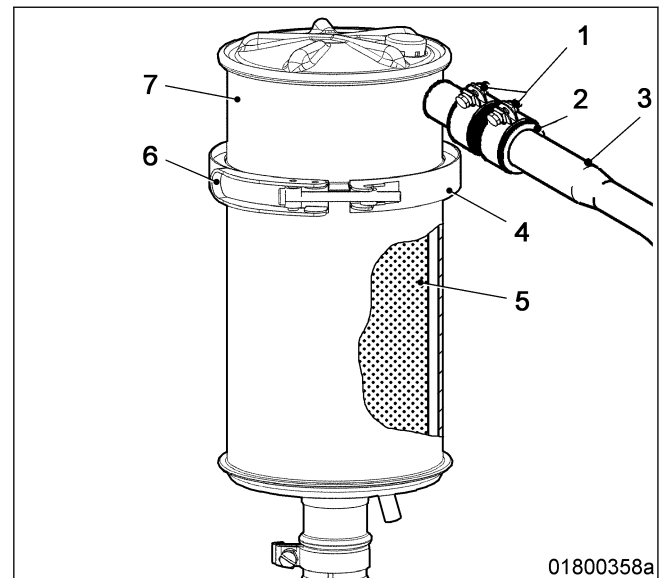
#### WARNING



- Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
  - Avoid contact with skin.
  - Do not inhale oil vapor.

#### Crankcase breather – Replacing filter element (variant A)

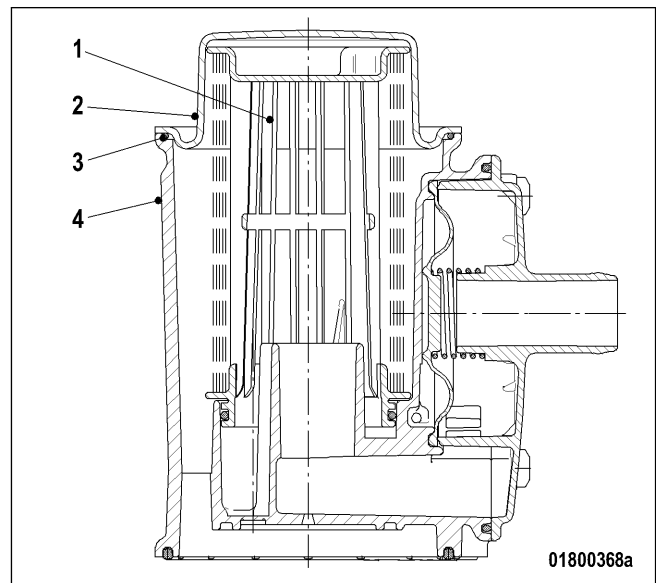
1. Release clamps (1).
2. Slide rubber sleeve (2) over pipe (3).
3. Release band clamp (4) with lever (6).
4. Remove cover (7).
5. Replace filter element (5).
6. Fit cover (7).
7. Tension band clamp (4) with lever (6).
8. Replace further oil filter elements in the same way.



01800358a

## Crankcase breather – Replacing filter element (variant B)

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Install cover (2) with new O-ring.



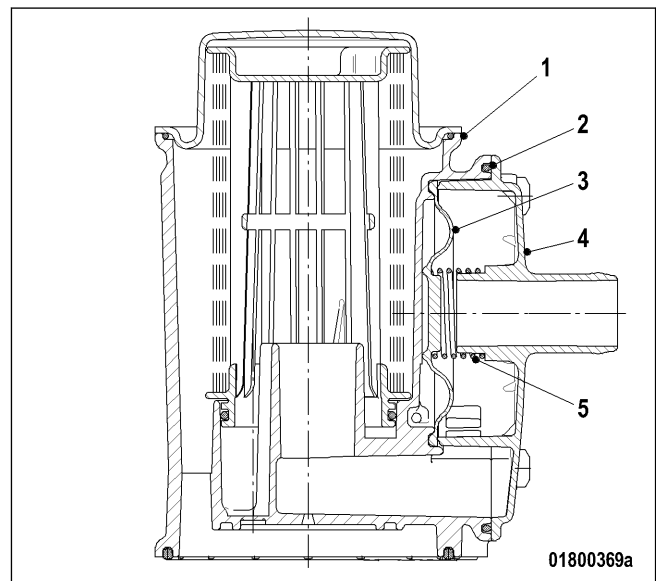
5. Use torque wrench to tighten the screws of cover (2) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	6 Nm +2 Nm

6. Replace further oil separator elements in the same way.

## Checking diaphragm (variant B)

1. Remove cover (4).
2. Remove spring (5), seal (2) and diaphragm (3).
3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
4. Install diaphragm (3) on housing (1).
5. Install new seal (2) and spring (5) together with cover (4).



6. Use torque wrench to tighten the screws of cover (4) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	6 Nm +2 Nm

7. Check diaphragms in further oil separators in the same way.

## 7.3.2 Crankcase breather – Cleaning

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (Hakupur 312)	30390	1

#### WARNING



Compressed air

#### **Risk of injury!**

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

#### WARNING



Cleaner is extremely caustic.

#### **Risk of injury and suffocation!**

- Avoid contact with eyes and skin.
- Do not inhale vapors and smoke.
- Do not eat, drink, smoke when working with cleaner.
- Wear protective clothing, gloves, and goggles / safety mask.
- Take measures against electrostatic charging.

#### CAUTION



Excessive reaction time of cleaning agents on components.

#### **Damage to component!**

- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

### Crankcase breather – Cleaning

Note: Protect rubber and synthetic components from oil and fuel, never treat with organic detergents. Wipe with a dry cloth only.

1. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 312).
2. Blow down all parts with compressed air.

### 7.3.3 Crankcase breather – Filter element replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench 10-60 Nm	F30510423	1
Filter element	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

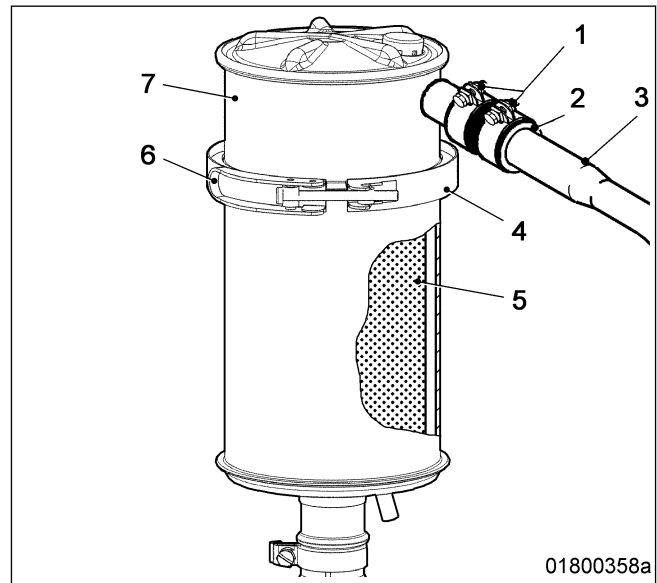
Oil can contain combustion residues which are harmful to health.

#### Risk of injury and poisoning!

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

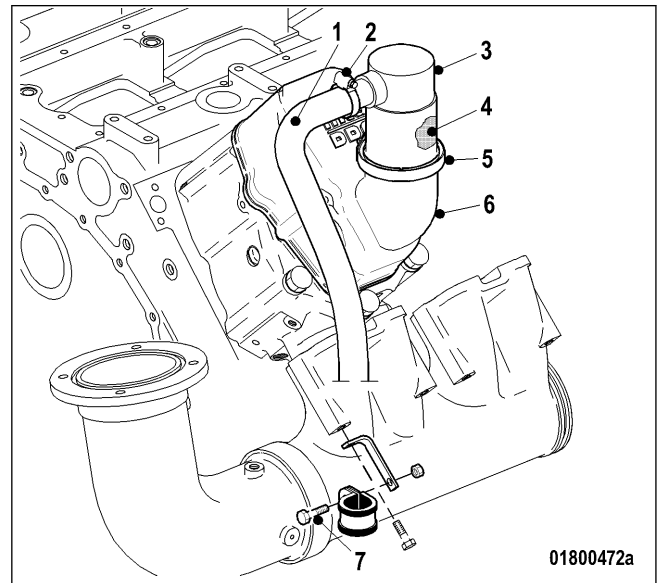
#### Crankcase breather (closed-circuit crankcase ventilation) – Filter element replacement

1. Loosen clamps (1), push rubber sleeves (2) over tubes (3).
2. Operate lever (6) to relieve clamping band (4).
3. Remove cover (7).
4. Replace filter element (5).
5. Fit cover (7).
6. Operate lever (6) to tension clamping band (4).
7. Push back rubber sleeve (2) and tighten clamp (1).
8. Replace further filter elements in the same way.



## Crankcase breather (open-circuit crankcase ventilation) – Filter element cleaning or replacement

1. Clean filter (6) outside.
2. Undo clamp (2) and screw (7).
3. Pull hose (1) off cover (3).
4. Loosen clamp (5).
5. Remove cover (3).
6. Clean filter element (4) (→ Page 65) or replace.
7. Fit cover (3).
8. Use torque wrench to tighten clamp (5) to specified torque 12 Nm to 14 Nm.
9. Push hose (1) onto cover (3).
10. Tighten clamp (2) and screw (7).
11. Replace further filter elements (2) in the same way.



## 7.4 Running Gear

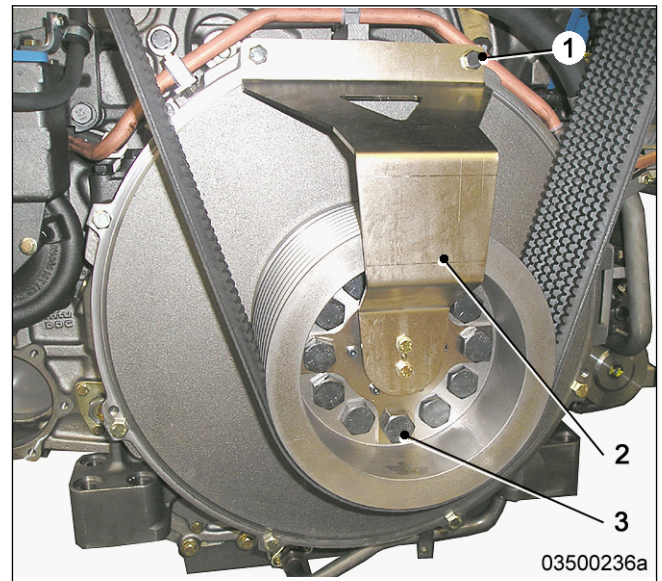
### 7.4.1 Grounding device – Removal and installation

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Removing grounding device

1. Clean grounding device (2) prior to removal.
2. Remove screws (1).
3. Remove screws (3) from grounding device (2).
4. Remove grounding device (2).



#### Installing grounding device

1. Install grounding device (2) with screws (3) on belt pulley.
2. Install screws (1) and tighten.



7.4.2 Grounding device – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grounding device	(→ Spare Parts Catalog)	

Remove grounding device and install new one .

- ▶ (→ Page 68)

## 7.5 Valve Drive

### 7.5.1 Valve gear – Lubrication

#### Preconditions

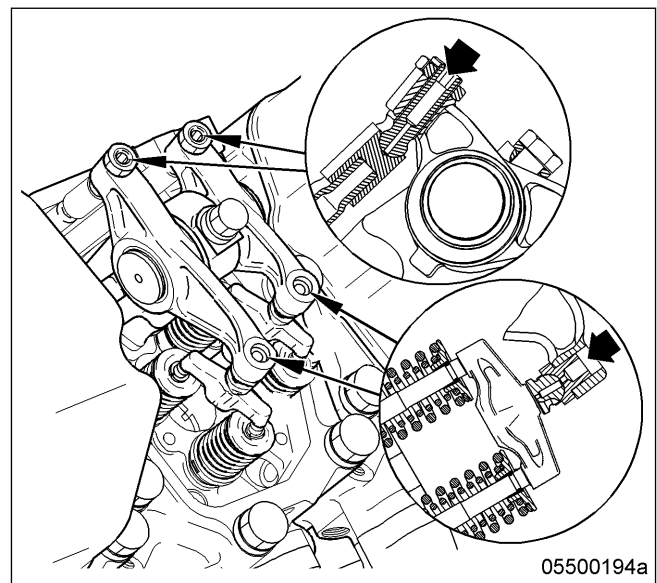
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

#### Lubricating valve gear

1. Remove cylinder head covers (→ Page 76).
2. Fill oil chambers of rocker arms and adjusting screws with oil.
3. Install cylinder head covers (→ Page 76).



## 7.5.2 Valve clearance – Check and adjustment

### Preconditions

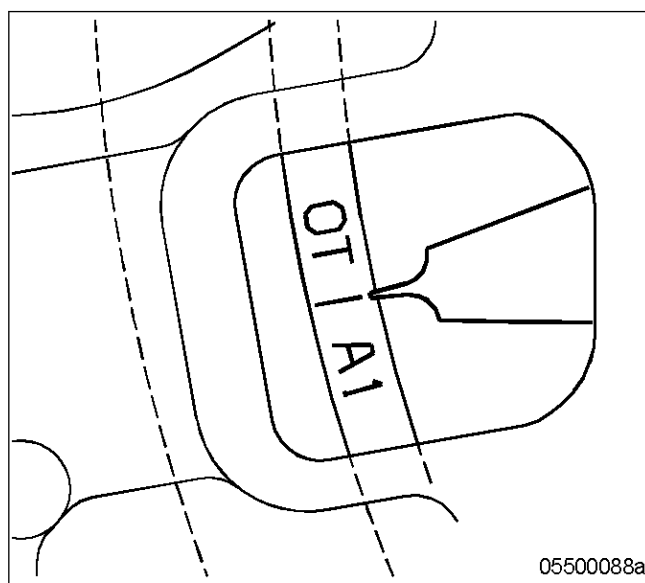
- ☑ Engine is stopped and starting disabled.
- ☑ Engine coolant temperature is max. 40 °C.
- ☑ Valves are closed.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench 60-320 Nm	F30047446	1
Socket wrench	F30039526	1
Allen key	F30002817	1
Torque wrench 10-60 Nm	F30510423	1
Socket wrench	F30039518	1

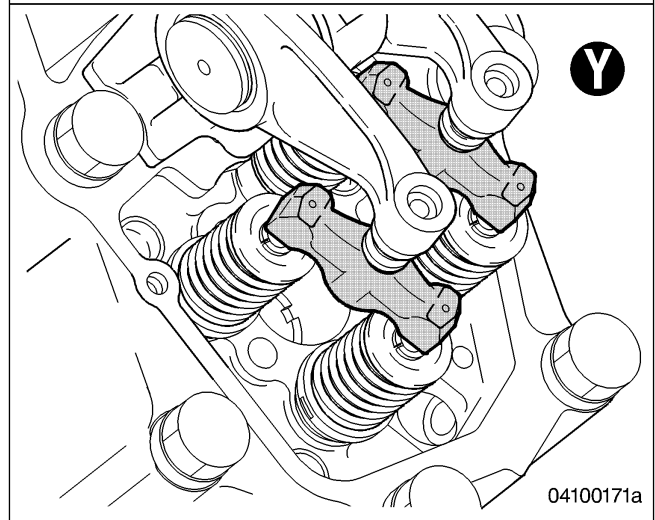
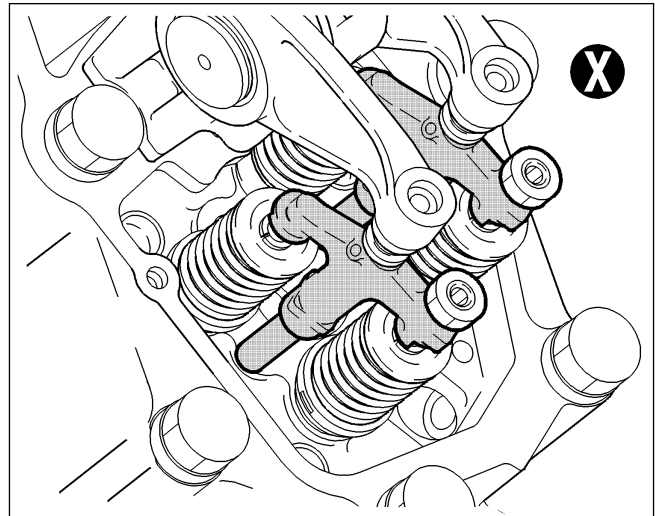
### Preparatory steps

1. Remove cylinder head cover (→ Page 76).
2. Install barring tool (→ Page 56).
3. Rotate crankshaft with barring tool in engine direction of rotation until marking "OT-A1" and pointer are aligned.

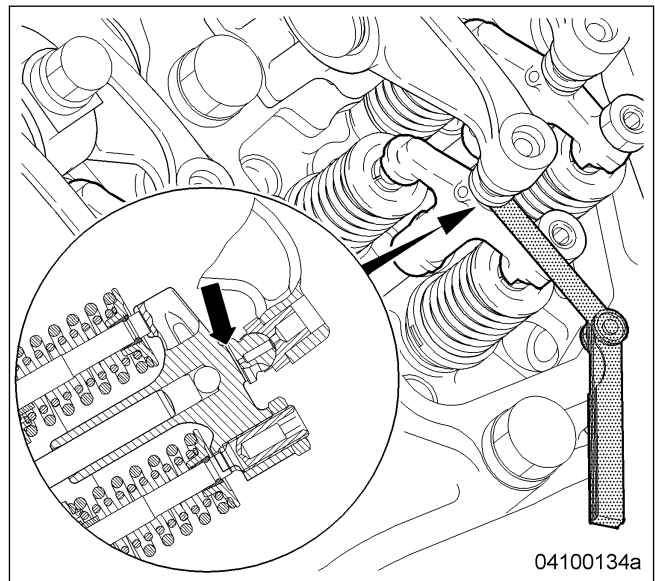


## Checking valve-bridge balance

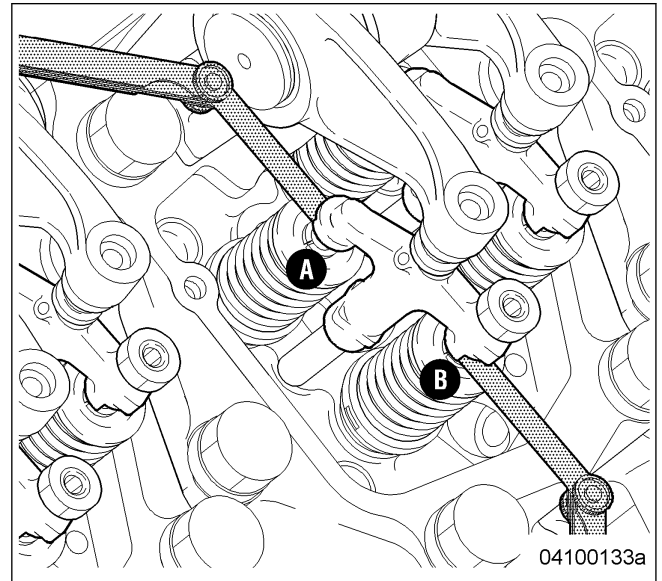
- X Valve bridge with guide
- Y Flying valve bridge



- Note: Not applicable for engines with flying valve bridge.
1. Prior to adjusting valve clearance, check valve-bridge balance on all valve bridges.
  2. Use feeler gauge to determine the distance between valve bridge and rocker arm.



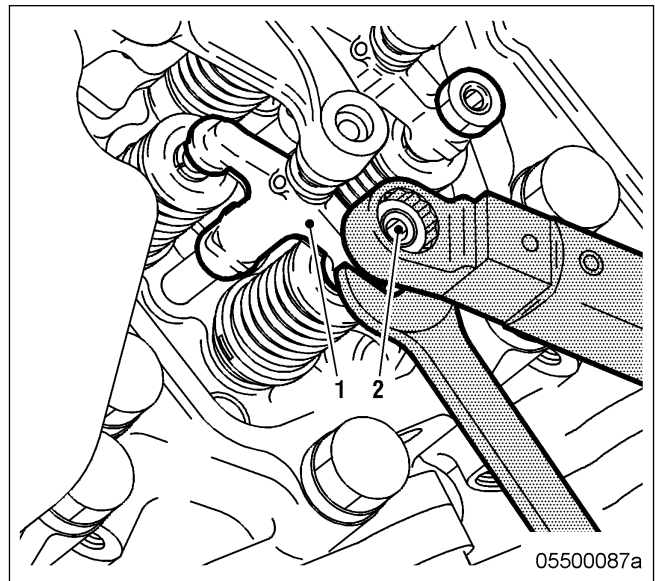
3. Insert feeler gauge with determined value between valve bridge and valve-stem end (A).
4. At the opposite valve-stem end (B), a feeler gauge thicker by 0.05 mm should not fit, otherwise adjust valve bridge balance.



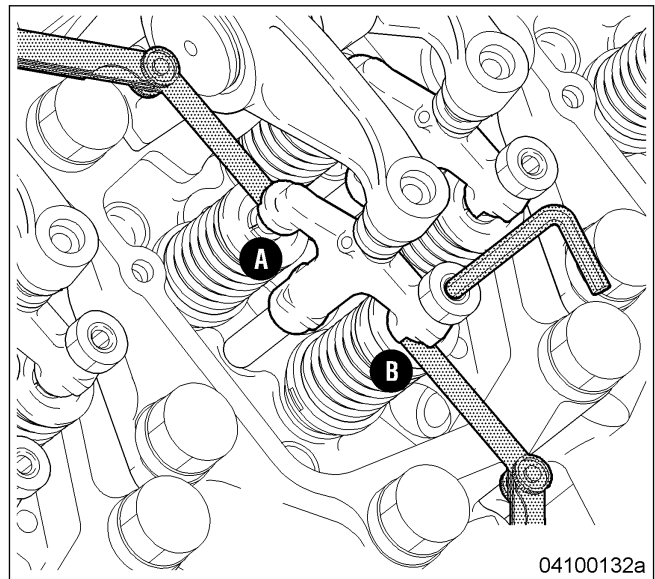
## Adjusting valve-bridge balance

Note: Not applicable for engines with flying valve bridge.

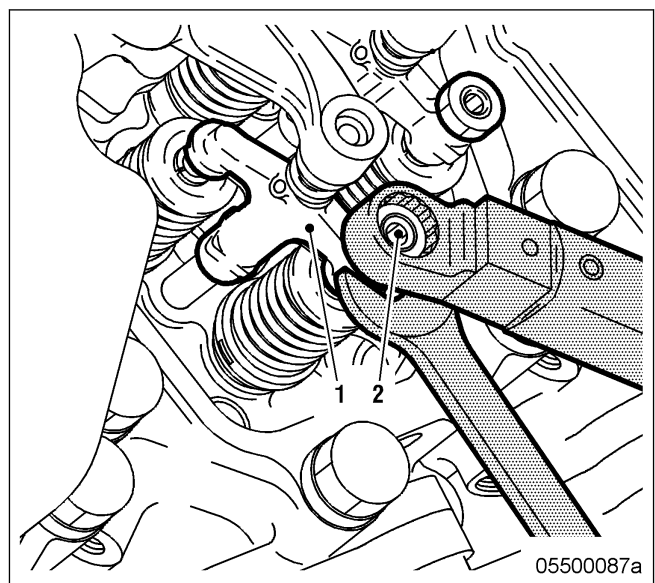
1. Hold valve bridge (1) firmly in position with open-end spanner and release locknut (2).



2. Use feeler gauge to determine the distance between valve bridge and rocker arm.
3. Place one feeler gauge (of the determined value) each between valve bridge and the two valve-stem ends (A) and (B).
4. Turn adjusting screw so that both feeler gauges can be just pulled through.
5. Hold adjusting screw securely in position with Allen key and fit locknut by hand on valve bridge.
6. Replace or rectify adjusting screws which do not move freely.

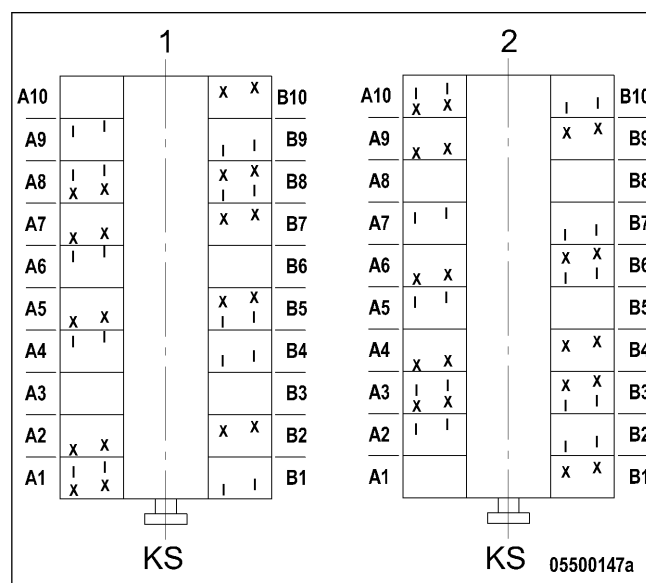


7. Tighten locknut (2) to 35 Nm +5 Nm, holding valve bridge (1) in position with open-end spanner.
8. Check valve bridge balance again.
9. Adjust valve-bridge balance at two crankshaft positions according to the following diagram.



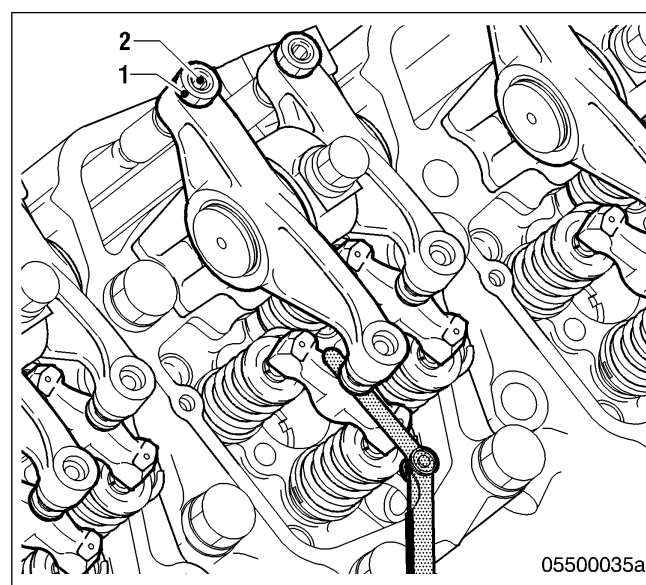
## Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
  - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
  - If the rocker arms are loaded on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
  - Inlet valves (long rocker arm) = 0.2 mm
  - Exhaust valves (short rocker arm) = 0.5 mm
3. Check all valve clearances at two crankshaft positions (firing and overlap TDC for cylinder A1) as per diagram.
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.



## Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gauge between valve bridge and rocker arm.
3. Using Allen key, set adjusting screw (2) so that the specified valve clearance is provided.
4. Feeler gauge must just pass through the gap.
5. Tighten locknut (1) to 90 +9 Nm, holding adjusting screw (2) firm.
6. Replace or rectify adjusting screws and/or locknuts which do not move freely.
7. Check valve clearance.



## Final steps

1. Remove barring tool (→ Page 56).
2. Install cylinder head cover (→ Page 76).

### 7.5.3 Cylinder head cover – Removal and installation

#### Preconditions

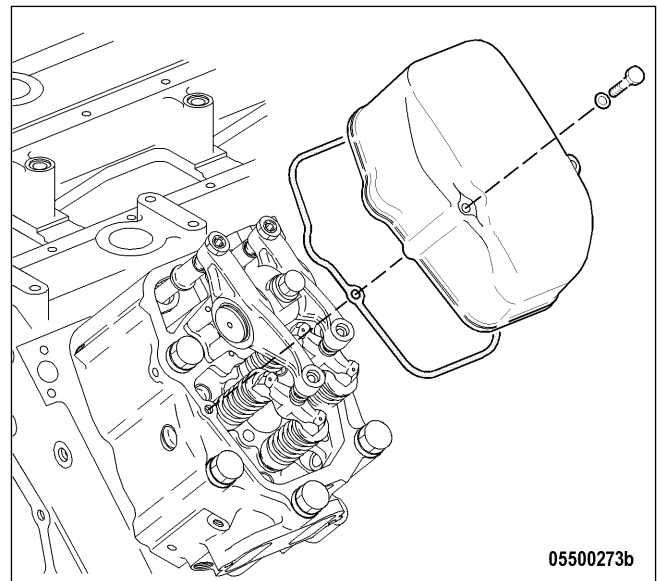
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

#### Removing cylinder head cover

1. Clean cylinder head covers prior to removal if they are heavily soiled.
2. Undo and remove screws.
3. Remove cylinder head cover with gasket from cylinder head.



#### Installing cylinder head cover

1. Clean mating faces.
2. Check condition of gasket, replace if necessary.
3. Place gasket and cylinder head cover on cylinder head.
4. Install cylinder head cover.



## 7.6 Injection Pump / HP Pump

### 7.6.1 HP fuel pump – Relief bore check

#### DANGER



Unguarded rotating and moving engine components.  
**Risk of serious injury – danger to life!**  
• Take special care when working on a running engine.

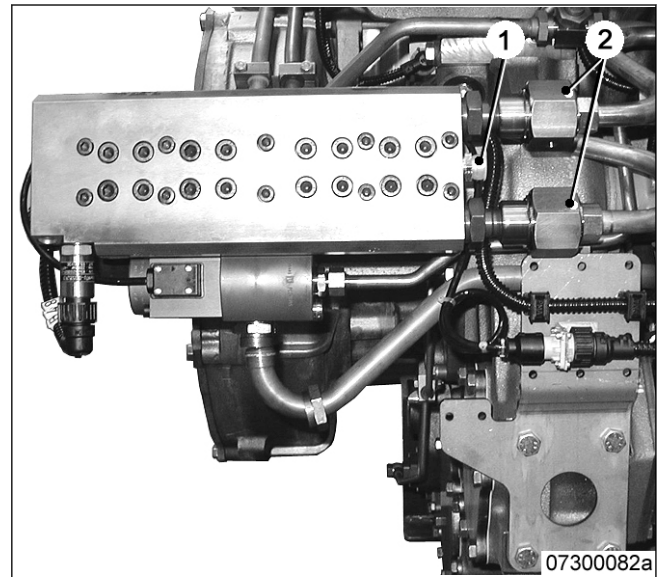
#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**  
• Wear ear protectors.

#### HP fuel pump – Relief bore check

1. Visually inspect relief bore (1) for fuel discharge.
2. For double-walled HP lines (2), leakage is indicated by the yellow combined alarm.
3. If fuel discharge is found or indicated, contact Service.



## 7.7 Injection Valve / Injector

### 7.7.1 Injector – Replacement

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Injector	(→ Spare Parts Catalog)	

#### Remove injector and install new injector.

- (→ Page 79)

## 7.7.2 Injector – Removal and installation

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation and removal tool for injector	F6790161	1
Milling cutter	F30452739	1
Slotted nut screwdriver	F30452578	1
Torque wrench, 0.5-5 Nm	0015384230	1
Torque wrench, 10-60 Nm	F30510423	1
Torque wrench, 60-320 Nm	F30047446	1
Assembly paste (Optimoly Paste White T)	40477	1
Grease (Kluth Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		

#### WARNING



Fuels are combustible.

#### **Risk of fire and explosion!**

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### CAUTION



Removal of all injectors.

#### **Damage to component!**

- Ensure that the high-pressure fuel accumulator is secured on the engine through two HP lines.

#### CAUTION



Cable damage during operation.

#### **Fire hazard!**

- Twist cables when installing.
- Ensure that cables do not touch components.

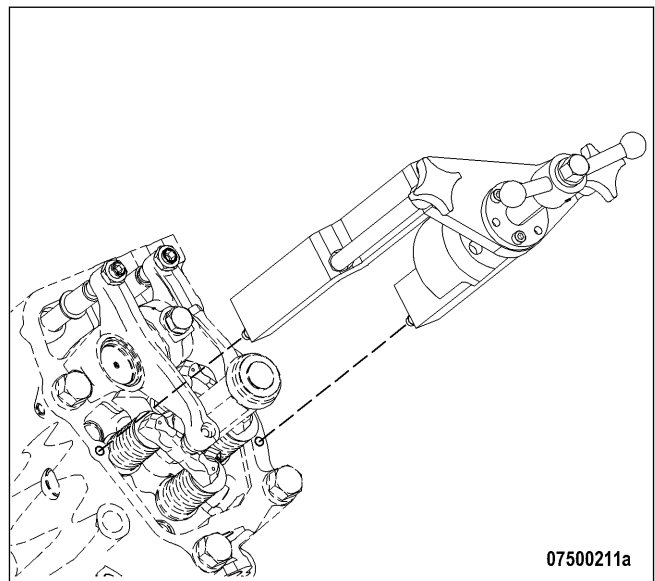
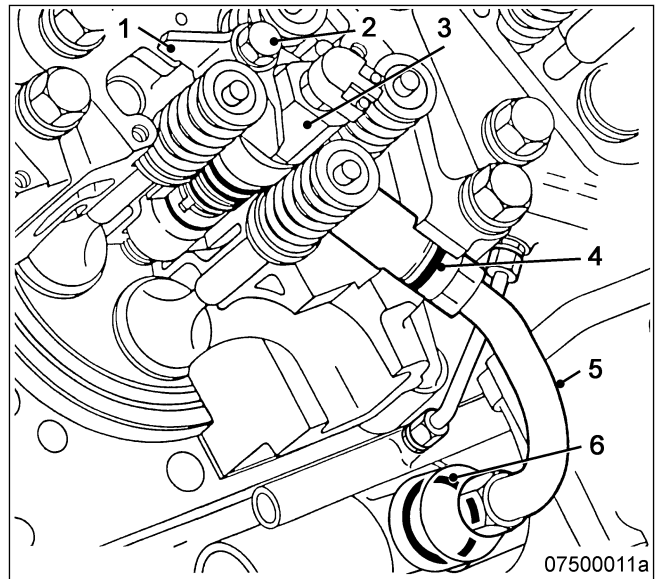
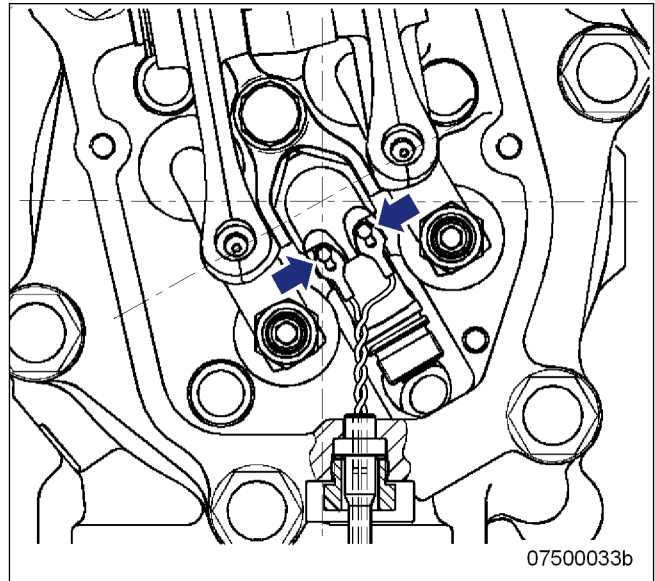
### Preparatory steps

1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 76).

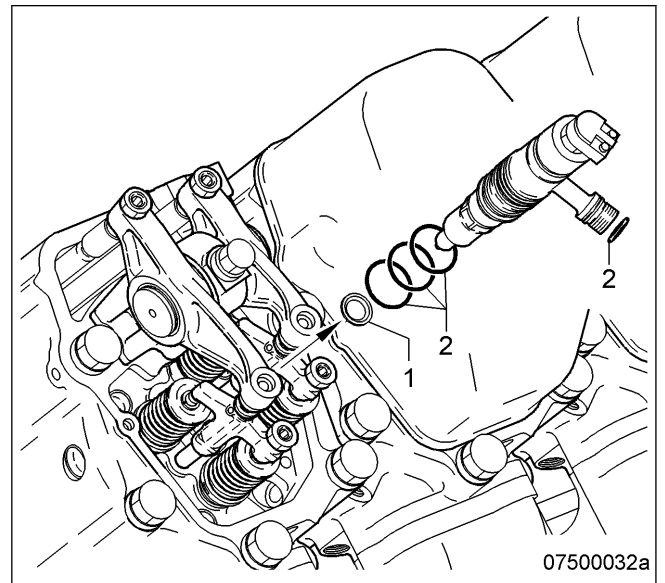
## Removing injector

Note: Always replace the first and last injectors of one engine side first. Replace the inner injectors only after the installation of the outer injectors on this engine side is completed.

1. Undo cable terminal screws (arrowed) on injector and remove cable terminals.
2. Remove screw (2) and take off hold-down clamp (1).
3. Remove high-pressure fuel line (5).
4. Install installation/removal jig on cylinder head.
5. Remove injector with installation/removal jig.
6. Remove installation/removal jig.

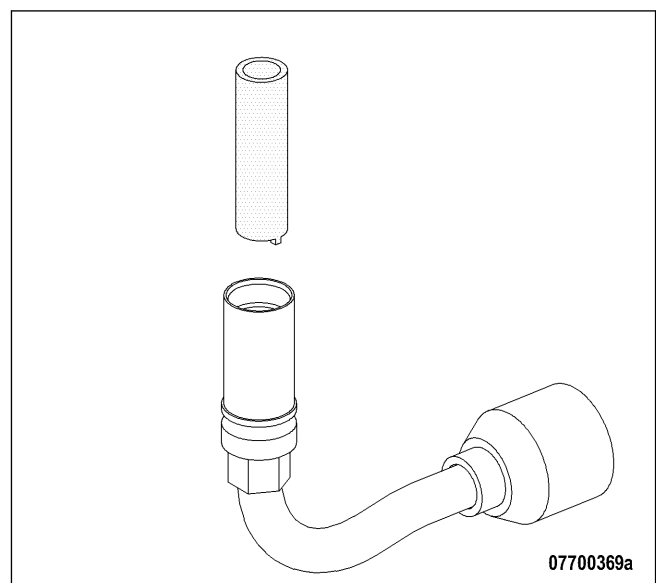
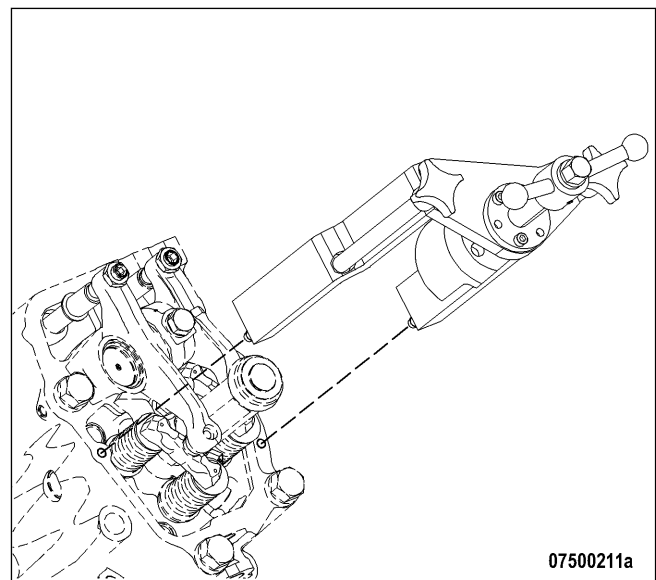
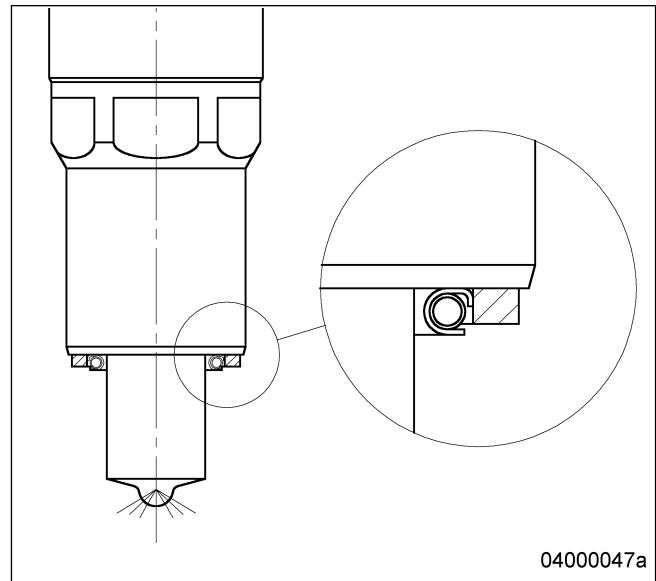


7. Remove sealing ring (1) from injector or use a self-made wire hook to extract it from the cylinder head.
8. Remove O-rings (2) from injector.
9. Cover all connections and bores, or seal with suitable plugs.



## Installing injector

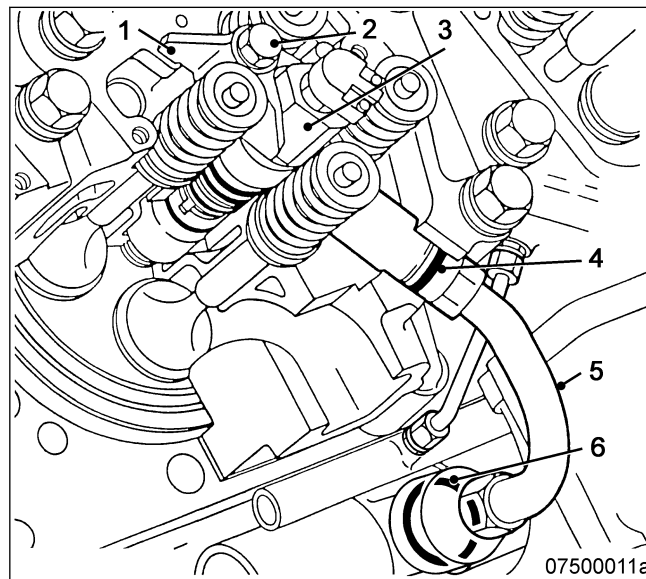
1. Remove all plugs before installing.
2. Coat nozzle retaining nut area of injector with assembly paste.
3. Fit new O-rings on injector and coat with grease.
4. Fit new sealing ring on injector with grease ensuring correct installation position of sealing ring.
5. Clean sealing surface on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head ensuring that the HP line connection is aligned correctly.
7. Press in injector with installation/removal jig.
8. Remove installation/removal jig.
9. Use slotted screwdriver to check thrust ring at both line ends for secure seating.



10. Tighten loose thrust ring to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust ring		Tightening torque		5 Nm to 10 Nm

11. Coat screw head mating face (2) and thread with engine oil.



12. Place hold-down clamp (1) in correct installation position. Tighten screw (2) with torque wrench to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Preload torque	(Engine oil)	5 Nm to 10 Nm

13. Fit O-rings (4) and (6) on high-pressure fuel line (5) and coat with grease.

14. Tighten high-pressure fuel line (5) to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
HP line		Preload torque	(Engine oil)	5 Nm to 10 Nm

15. Tighten screw (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Tightening torque		100 Nm + 10 Nm

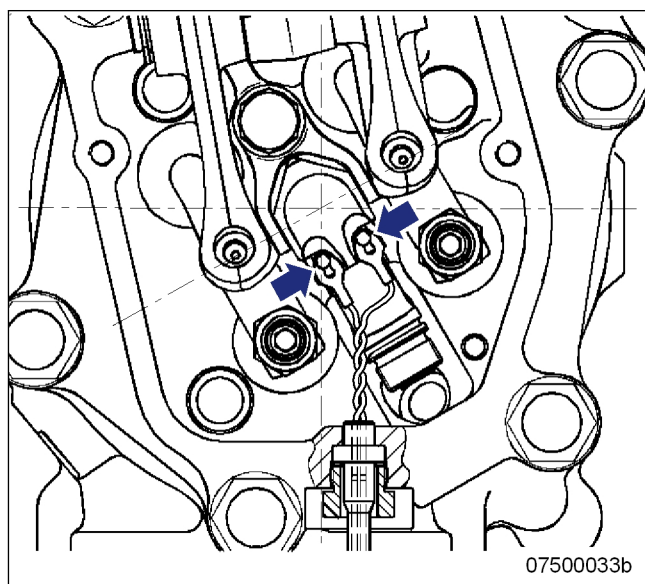
16. Tighten union nut of connecting piece (limiting valve) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		140 Nm + 10 Nm

17. Tighten union nut of connecting piece (injector) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		120 Nm + 10 Nm

18. Twist cable several times.



19. Insert cable terminals (arrowed) underneath screws on injector and tighten screws to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		1.5 Nm

### Final steps

1. Install cylinder head cover (→ Page 76).
2. Open up fuel supply to engine.



## 7.8 Fuel System

### 7.8.1 Fuel system – Venting

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

#### WARNING



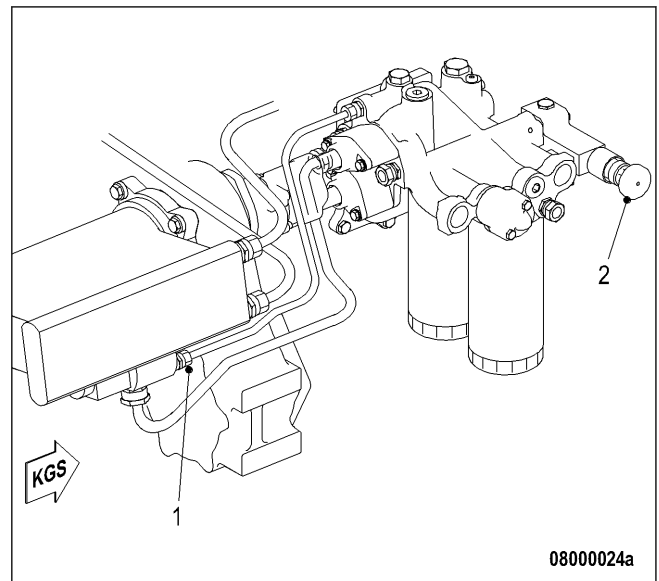
Fuels are combustible.

#### **Risk of fire and explosion!**

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Venting LP fuel system

1. Loosen flushing/return line of HP pump at connection (1).
2. Unlock fuel priming pump (2), screw out handle.
3. Operate the fuel priming pump (2) with the handle until bubble-free fuel comes out of the connection (1).
4. Lock fuel priming pump (2), screw in handle.
5. Verify that fuel priming pump (2) is locked: handle must be tightened.
6. Tighten connection (1) of flushing/return line.



## 7.9 Fuel Filter

### 7.9.1 Fuel filter – Replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	

#### WARNING



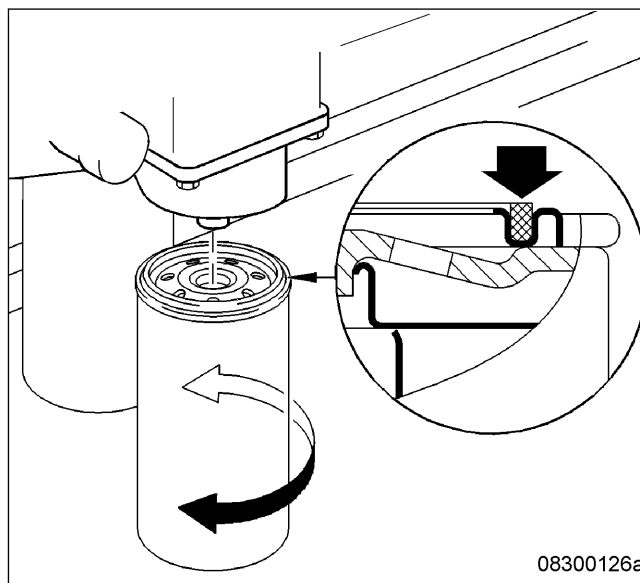
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Replacing fuel filter

1. Remove easy-change filter using filter wrench.
2. Clean sealing surface on filter head.
3. Slightly lubricate seal on the easy-change filter.
4. Screw on easy-change filter by hand until the seal connects and tighten manually.
5. Vent fuel system (→ Page 85).
6. Replace other easy-change filters in the same way.



## 7.9.2 Edge-type fuel filter – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



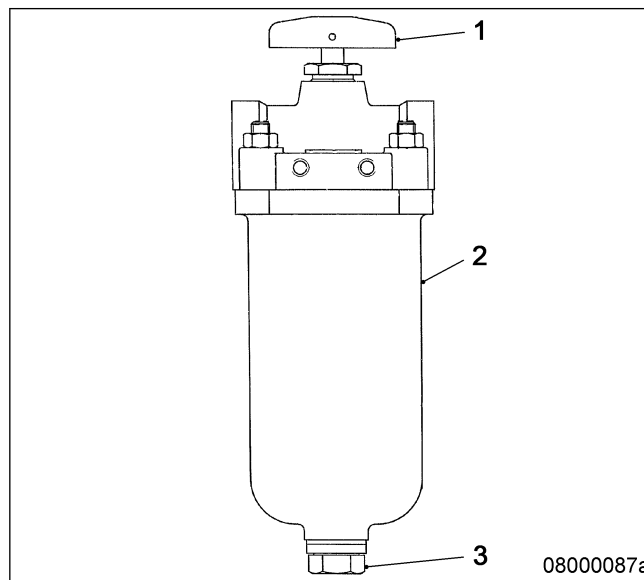
Fuels are combustible.

#### **Risk of fire and explosion!**

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Edge-type fuel filter – Draining

1. Rotate edge-type filter (2) with handle (1) clockwise several times.
2. Do not apply force when rotating handle.
3. Close fuel supply.
4. Remove drain plug (3) from edge-type filter (2).
5. Drain water and contaminants through drain plug opening (3) until pure fuel emerges from filter.
6. Fit drain plug (3) with new sealing ring and screw in.
7. Open fuel supply.



## 7.9.3 Fuel prefilter – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

#### WARNING



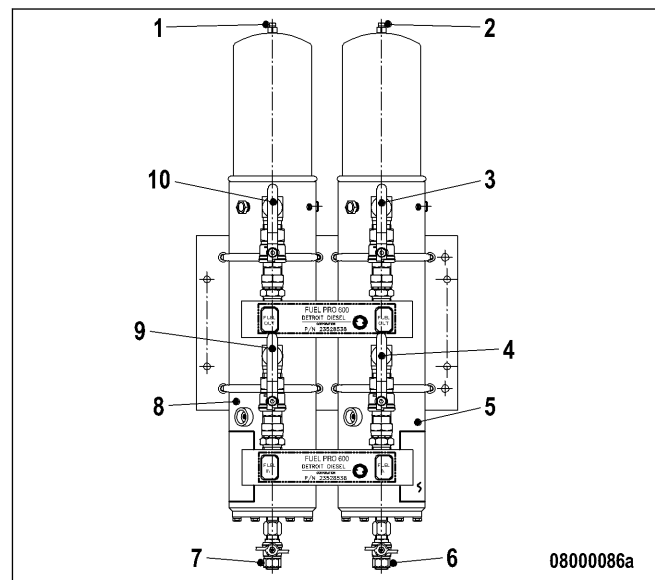
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Draining fuel prefilter

1. Shut down the filter unit (5/8) to be changed at valves (3) and (4) or (9) and (10).
2. Open threaded vent plug (1) or (2) on filter to be drained.
3. Open drain valve (6) or (7).
4. Drain water and contaminants from the filter until pure fuel emerges.
5. Close drain valve (6) or (7).
6. Open fuel return line (3) or (10).
7. Open fuel inlet (4) or (9).
8. Close threaded vent plug (1) or (2) on filter to be drained when clean fuel emerges.



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## 7.10 Charge-Air Cooling

### 7.10.1 Intercooler – Check drain for coolant leakage and obstruction

#### DANGER



Unguarded rotating and moving engine components.  
**Risk of serious injury – danger to life!**  
• Take special care when working on a running engine.

#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**  
• Wear ear protectors.

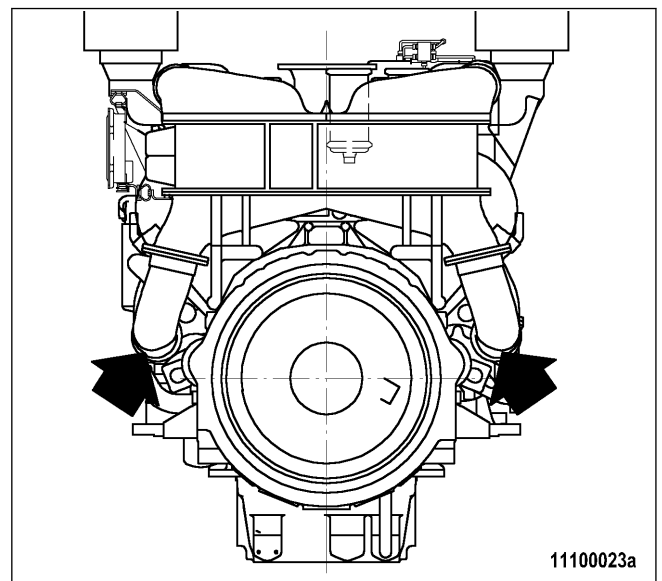
#### WARNING



Compressed air  
**Risk of injury!**  
• Do not direct compressed-air jet at persons.  
• Wear protective goggles / safety mask and ear protectors.

#### Intercooler – Check drain for coolant leakage and obstruction

1. Verify that air emerges from condensate drain bore(s) on left and right engine sides at driving end when engine is running. If no air emerges:
  - Clean drain bore(s)
  - Blow out with compressed air
2. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



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#### Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 79).
2. Bar engine manually (→ Page 56).
3. Crank engine on starting system to blow out combustion chambers (→ Page 58).
4. Install injectors (→ Page 79).

## 7.11 Air Filter

### 7.11.1 Air filter element and dust bowl – Cleaning

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Seal	(→ Spare Parts Catalog)	

#### WARNING



Compressed air

#### Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

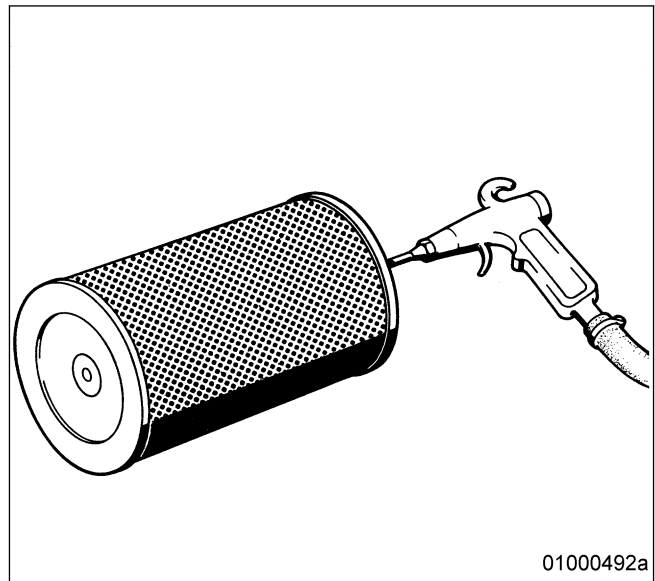
#### Air filter element – Cleaning

Note: Clean paper filter element dry only.

1. Open air filter and remove filter element (→ Page 93).
2. Check seal for damage and cleanness, replace if necessary.
3. Clean all mating and sealing surfaces.

Note: Debris particles must not enter the intake system.

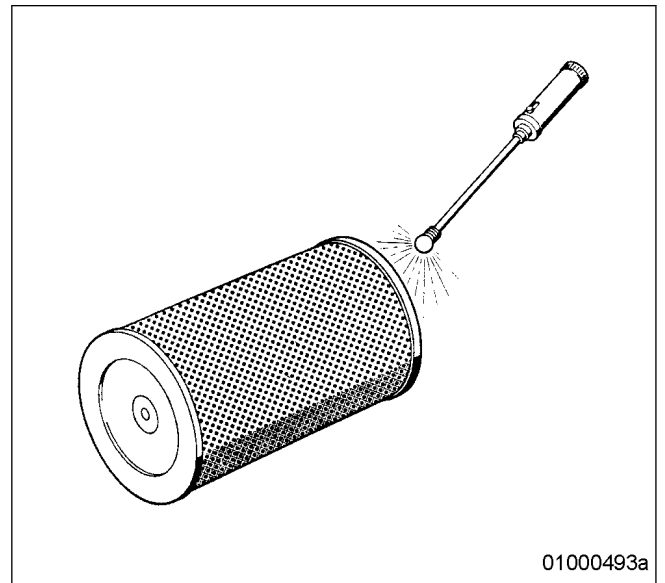
4. Clean dust bowl.
5. Blow out filter element with compressed air (max. 3 bar) from inside until all dust has been removed.
6. Fit new filter element if old one is heavily contaminated or damaged (→ Page 92).



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## Visual inspection

1. Use inspection lamp to check cleaned filter element for damage.
2. Fit new filter element if old one is damaged (→ Page 92).



## 7.11.2 Air filter – Replacement

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

### Remove air filter and install new one .

- ▶ (→ Page 93)

### Reset signal ring of service indicator .

- ▶ (→ Page 94)



### 7.11.3 Air filter element – Removal and installation

#### Preconditions

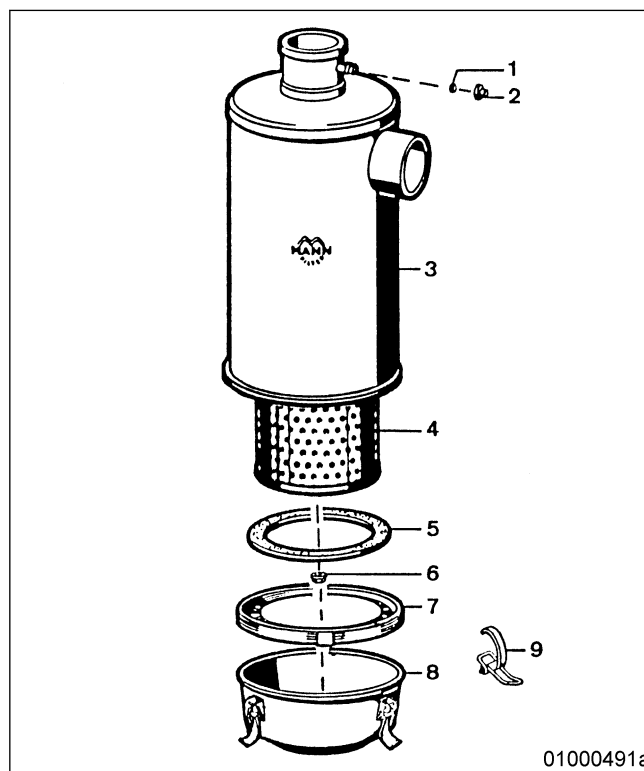
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Seal	(→ Spare Parts Catalog)	

#### Air filter element – Removal and installation

1. Release latches (9).
2. Remove dust bowl (8) and partition (7).
3. Remove collar nut (6).
4. Screw off air filter element (4).
5. Clean housing (3) and dust bowl (8).
6. Check seal (5) for damage and cleanness, replace if necessary.
7. Clean all mating and sealing surfaces.
8. Fit partition (7) and dust bowl (8) according to marking.
9. Secure dust bowl (8) with latches (9).



#### 7.11.4 Service indicator - Signal ring position check

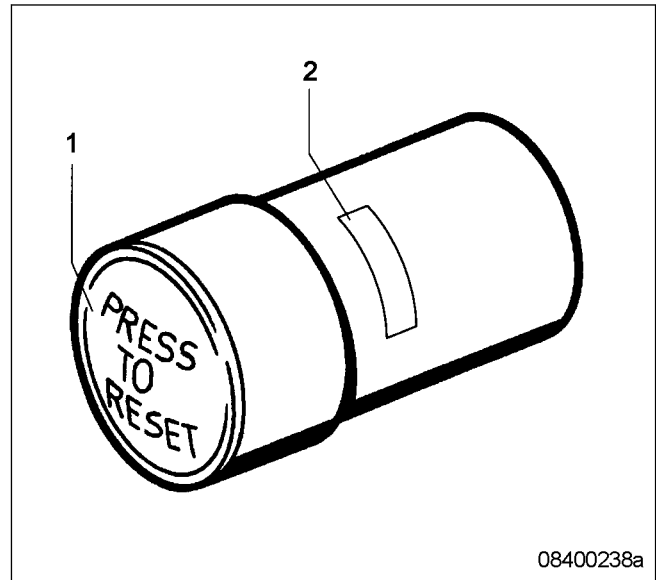
##### Preconditions

- ☑ Engine is stopped and starting disabled.

##### Checking signal ring position

1. If the signal ring is completely visible in the control window (2), replace air filter (→ Page 92).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.



## 7.12 Starting Equipment

### 7.12.1 Starter – Condition check

#### **Preconditions**

- ☒ Engine is stopped and starting disabled.

#### **Checking starter condition**

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 128).

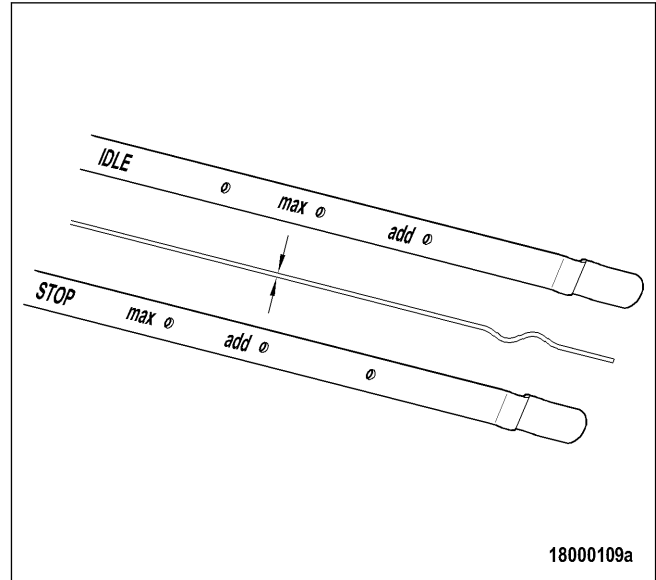
## 7.13 Lube Oil System, Lube Oil Circuit

### 7.13.1 Engine oil level – Check

#### Checking engine oil level prior to engine start

1. Withdraw oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".

- Note: After extended out-of-service periods, the oil level may be up to 2 cm above the "max." mark. This might be caused by engine oil flowing from oil filter and heat exchanger back into the oil pan.
3. The oil level must reach the "max." mark or exceed it by up to 2 cm.
  4. If necessary, top up to "max." mark (→ Page 97).
  5. Insert oil dipstick into guide tube up to the stop.



#### Checking engine oil level with the engine running

1. After the engine has run for approx. 10 minutes at a constant speed of 900 rpm, withdraw oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, withdraw after approx. 10 seconds. Check oil level on the dipstick side marked "IDLE".
3. Oil level must not be lower than the "add" mark.
4. If necessary, top up to "max." mark (→ Page 97).

#### Checking engine oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".
3. Oil level must be between "add." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 97).
5. Insert oil dipstick into guide tube up to the stop.

## 7.13.2 Engine oil – Change

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.
- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

#### **Risk of injury and poisoning!**

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

### Procedure without pump: Draining oil at drain plug on oil pan

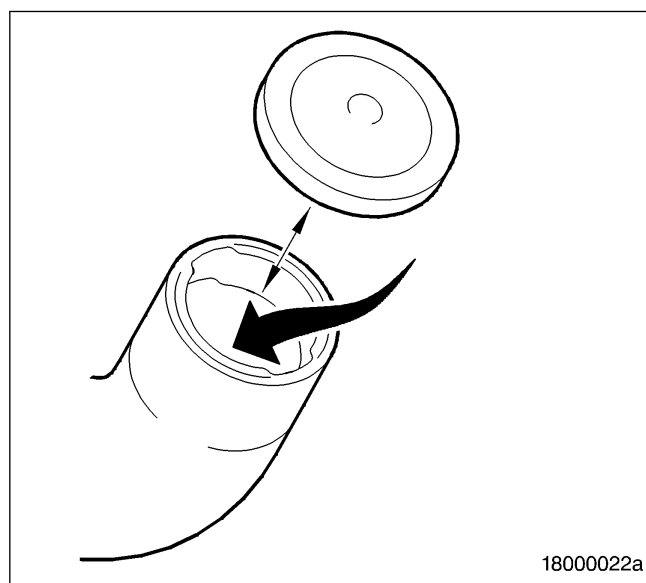
1. Provide a suitable container in which to collect the oil.
2. Remove drain plug and drain oil.
3. Install drain plug with new sealing ring.

### Procedure with pump: Oil extraction

1. Provide a suitable container in which to collect the oil.
2. Extract all oil from oil pan using the pump.

### Filling with new oil

1. Open cover of filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover of filler neck.
4. Check engine oil level (→ Page 96).
5. After oil change, bar engine with starting system (→ Page 58).



## 7.14 Oil Filtration / Cooling

### 7.14.1 Automatic oil filter – Filter candles replacement

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	
Oil filter candles	(→ Spare Parts Catalog)	

#### WARNING



- Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
  - Avoid contact with skin.
  - Do not inhale oil vapor.

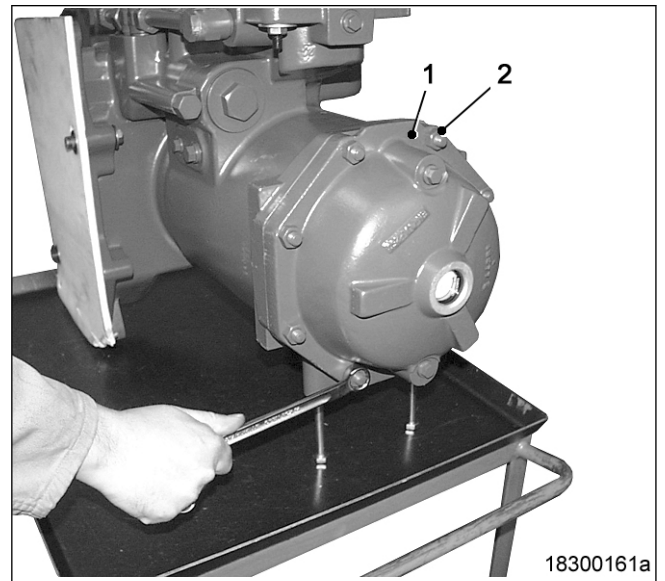
#### CAUTION



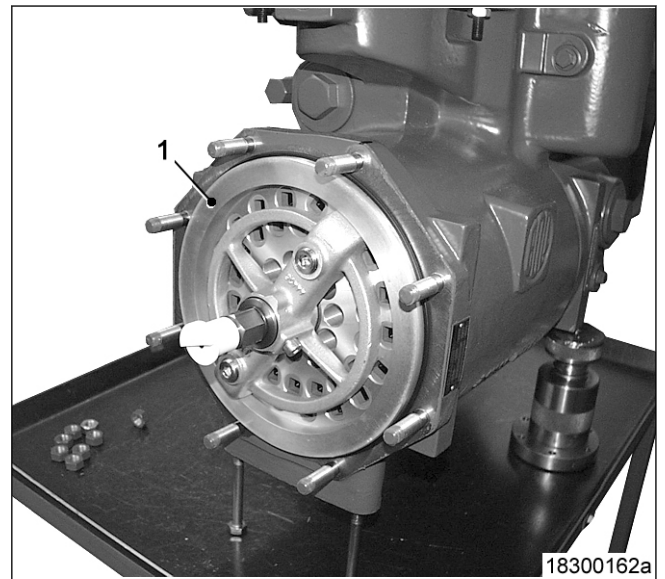
- Contamination of components.  
**Damage to component!**
- Observe manufacturer's instructions.
  - Check components for special cleanness.

## Oil filter candles – Removal

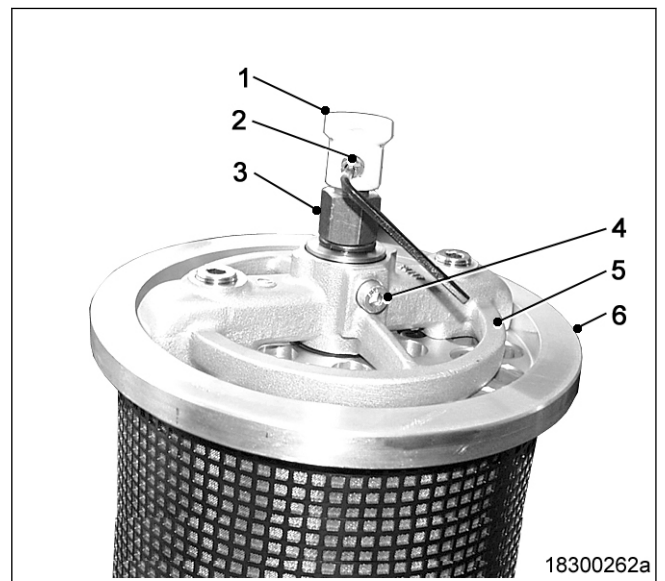
1. Remove nuts (2) from oil filter cover (1).
2. Remove oil filter cover.



3. Withdraw filter insert (1).
4. Remove O-ring.



5. Remove screw (2).
6. Withdraw spinner (1) with spring.
7. Remove nut (3).
8. Take off spring washer and washer.
9. Remove screw (4).
10. Remove flushing arm (5) from screen plate (6).



11. Turn filter insert upside down and use appropriate tool to push out filter candles (1).
12. Turn filter insert by 180° and insert new filter candles (1) with chamfer facing downwards.



### Oil filter candles – Installation

1. For installation follow reverse sequence of working steps.
2. In addition, the following work must be performed:
  - Replace all sealing elements with new parts.
  - Coat O-rings with grease.
  - Insert O-rings in grooves.
  - Pay attention to installation position of fillister-head screw to slot in shaft.



## 7.14.2 Oil indicator filter – Check

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Strainer	(→ Spare Parts Catalog)	
Square-section ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

#### WARNING



Compressed air  
**Risk of injury!**

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

#### CAUTION

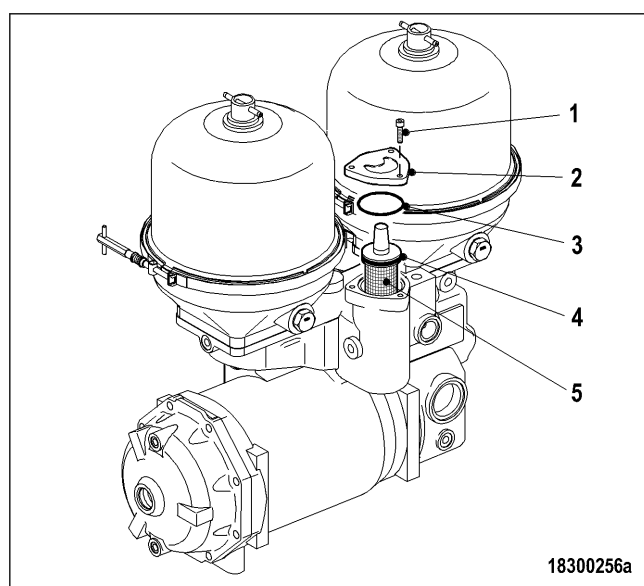


Unsuitable cleaning tool.  
**Damage to component!**

- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

### Removing strainer

1. Clean oil indicator filter before disassembling it.
2. Remove screws (1).
3. Take off cover (2) with O-ring (3).
4. Take strainer (5) from filter housing.



## Checking strainer

Item	Findings	Task
Strainer	Metallic residues	<ul style="list-style-type: none"><li>• Clean</li><li>• Monitor engine operation</li><li>• Check strainer daily</li><li>• Contact Service.</li></ul>
Strainer	Damaged	Replace
Square-section ring	Damaged	Replace
O-ring	Damaged	Replace

## Cleaning strainer

1. Wash strainer (5) with cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out strainer (5) with compressed air from inside.

## Installing strainer

1. Coat square-section ring (4) on strainer (5) with engine oil and install strainer (5).
2. Coat O-ring (3) with engine oil and fit in filter housing.
3. Fit cover (2) and secure with screws (1) and washers.

### 7.14.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Cold cleaner (Hakutex 60)	X00056750	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

#### WARNING

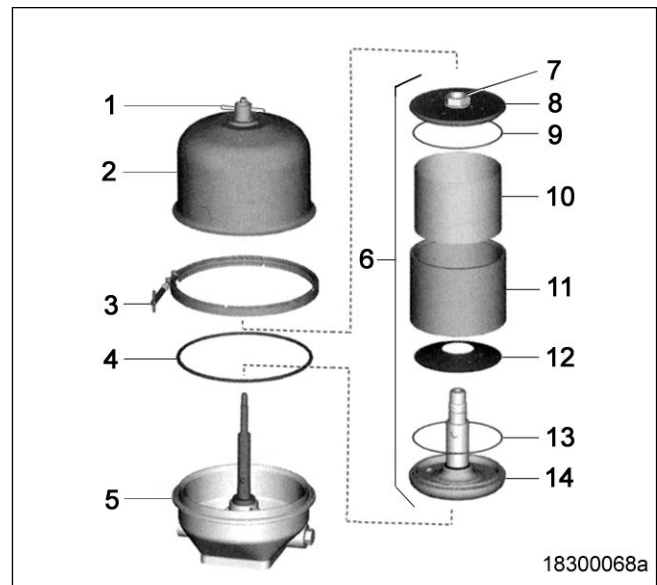


Compressed air  
**Risk of injury!**

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

## Centrifugal oil filter – Cleaning and filter-sleeve replacement

1. Remove clamp (3).
2. Release cover screw (1) and take off cover (2).
3. Carefully lift rotor (6), allow oil to drain and remove from housing.
4. Holding the rotor (6) firmly, release rotor cover nut (7).
5. Take off rotor cover (8).
6. Remove filter sleeve (10).
7. Measure thickness of oil residues on filter sleeve (10).
8. If maximum layer thickness of oil residues exceeds 45 mm, shorten maintenance interval.
9. Disassemble rotor tube (11), conical disk (12) and rotor base (14).
10. Wash rotor cover (8), rotor tube (11), conical disk (12) and rotor base (14) with cold cleaner.
11. Blow out with compressed air.
12. Check sealing ring (13), fit new one if necessary.
13. Assemble rotor tube (11), conical disk (12) and rotor base (14) with sealing ring (13).
14. Insert new filter sleeve (10) in rotor tube (11) with the smooth paper surface facing the wall.
15. Check sealing ring (9), fit new one if necessary.
16. Mount rotor cover (8) with sealing ring (9).
17. Tighten rotor cover nut (7) with torque wrench to the specified torque.



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18. Place rotor (6) in housing (5) and check for ease of movement.
19. Check sealing ring (4), fit new one if necessary.
20. Fit sealing ring (4) on housing (5).
21. Fit cover (2).
22. Fit cover screw (1) by hand.
23. Install clamp (3) and tighten with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		35 Nm to 45 Nm

24. Tighten cover nut (1) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		5 Nm to 7 Nm

## 7.15 Coolant Circuit, General, High-Temperature Circuit

### 7.15.1 Coolant – Level check

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### WARNING



Coolant is hot and under pressure.

#### Risk of injury and scalding!

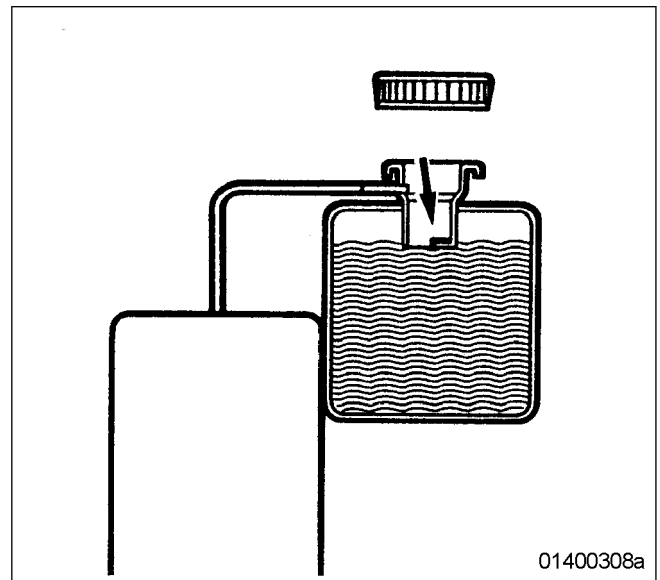
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Checking coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye).

#### Checking coolant level at remote cooler:

1. Check coolant level (coolant must be visible at marking plate).
2. Top up coolant if necessary (→ Page 108).
3. Check and clean breather valve.
4. Set breather valve onto filler neck and close it.



#### Coolant level check by means of level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up coolant if necessary (→ Page 108).

## 7.15.2 Engine coolant – Change

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

#### Drain engine coolant.

- ▶ (→ Page 107)

#### Fill with engine coolant.

- ▶ (→ Page 108)

### 7.15.3 Engine coolant – Draining

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



Coolant is hot and under pressure.

#### Risk of injury and scalding!

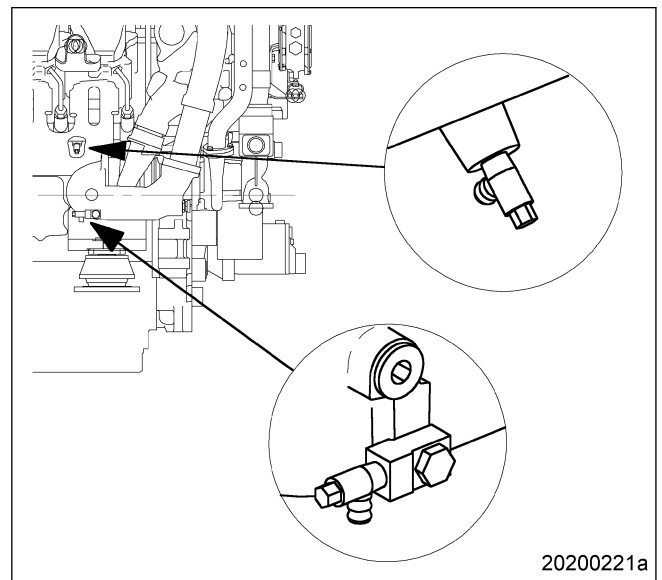
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Preparatory steps

1. Provide an appropriate container to drain the coolant into.
2. Switch off preheating unit.

#### Engine coolant – Draining

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain valves and/or drain plugs and drain coolant at the following points:
  - At preheating unit;
  - At HT coolant pump elbow;
  - On crankcase, left and right side.
5. Close all open drain points.
6. Set breather valve onto filler neck and close it.



## 7.15.4 Engine coolant – Filling

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

#### WARNING



Coolant is hot and under pressure.

#### **Risk of injury and scalding!**

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### CAUTION



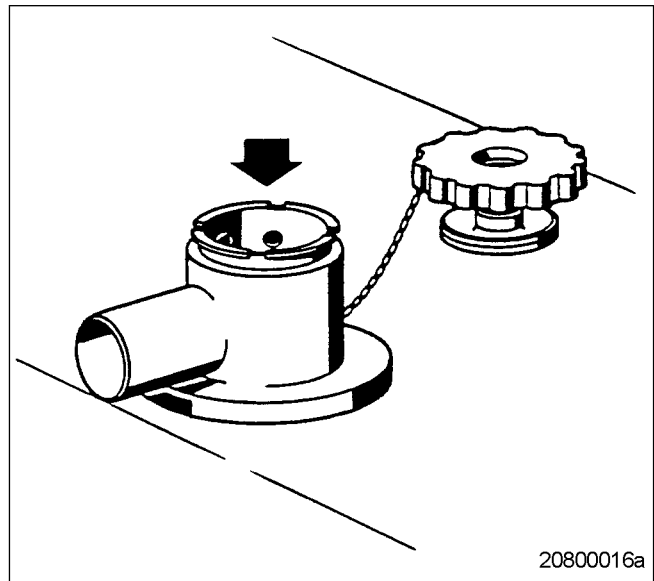
Cold coolant in hot engine can cause thermal stress.

#### **Formation of cracks in components!**

- Fill / top up coolant only into cold engine.

### Preparatory steps

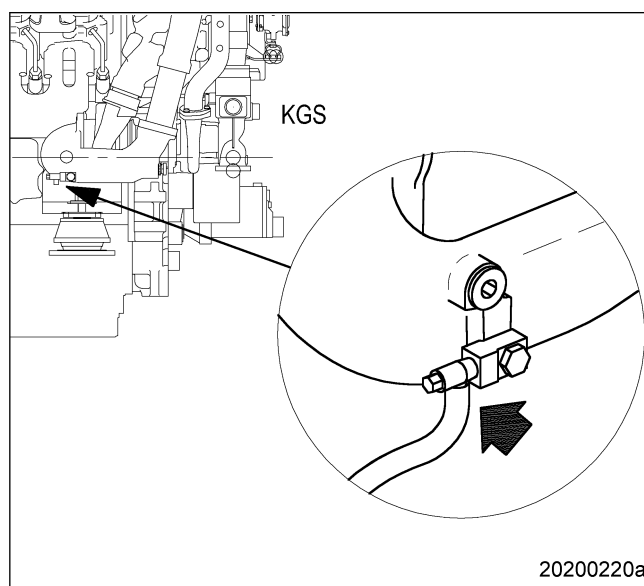
1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.





## Filling coolant with pump

1. Connect appropriate pump with hose to drain valve.
2. Open drain valve and pump coolant into engine at 0.5 bar minimum.
3. Fill expansion tank until overflow edge is reached.
4. Close drain valve.
5. Check proper condition of breather valve, clean sealing faces if required.
6. Set breather valve onto filler neck and close it.
7. Start engine (→ Page 35).
8. After the engine has run at unloaded condition for 10 seconds, stop engine (→ Page 37).
9. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
10. Continue to turn breather valve counterclockwise and remove.
11. Check coolant level (→ Page 105) and top up if required:
  - a) Fill in coolant in expansion tank until the coolant level at top edge of filler neck remains constant.
  - b) Set breather valve onto filler neck and close it.
  - c) Repeat the steps from "Start engine" (→ Step 7) until coolant is no longer needed to be topped up.
  - d) Disconnect pump and hose.



## Filling coolant through filler neck

1. Alternatively: Fill in coolant in expansion tank until the coolant level at top edge of filler neck remains constant.
2. Check proper condition of breather valve, clean sealing faces if required.
3. Set breather valve onto filler neck and close until first stop is reached.
4. Start engine (→ Page 35).
5. After the engine has run at unloaded condition for 10 seconds, stop engine (→ Page 37).
6. Turn breather valve counterclockwise and remove.
7. Check coolant level (→ Page 105) and top up if required:
  - a) Repeat the steps from "Start engine" (→ Step 4) until coolant is no longer needed to be topped up.
  - b) Check proper condition of breather valve, clean sealing faces if required.
  - c) Set breather valve onto filler neck and close it.

## Final steps

1. Start the engine and operate it at unloaded condition for some minutes.
2. Check coolant level (→ Page 105) and top up if required.

### 7.15.5 Engine coolant pump – Relief bore check

#### DANGER



Unguarded rotating and moving engine components.  
**Risk of serious injury – danger to life!**  
• Take special care when working on a running engine.

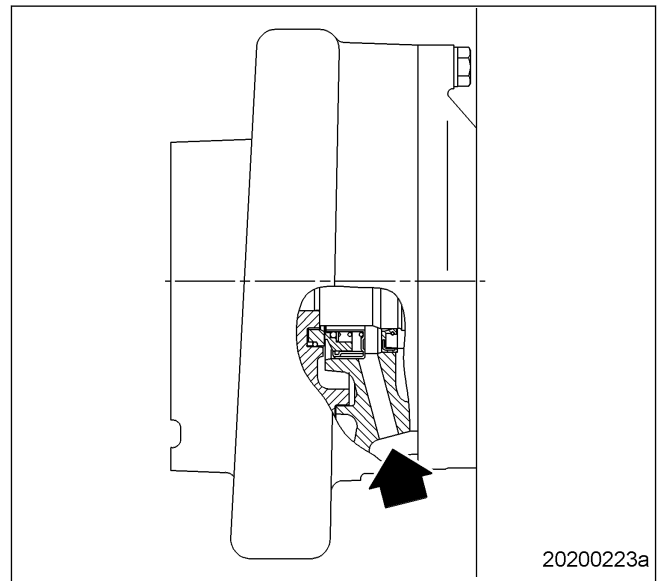
#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**  
• Wear ear protectors.

#### Checking relief bore on engine coolant pump

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 37) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
  - Permissible coolant discharge: up to 10 drops per hour.
  - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.



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## 7.15.6 Coolant – Sample extraction and analysis

### Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

#### DANGER



Unguarded rotating and moving engine components.  
**Risk of serious injury – danger to life!**  
• Take special care when working on a running engine.

#### WARNING



Coolant is hot and under pressure.  
**Risk of injury and scalding!**  
• Let the engine cool down.  
• Wear protective clothing, gloves, and goggles / safety mask.

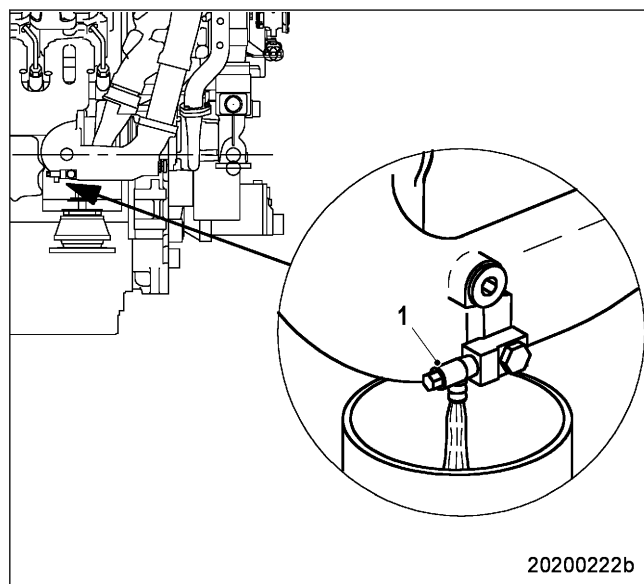
#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**  
• Wear ear protectors.

### Coolant – Sample extraction and analysis

1. With the engine running, open drain valve (1).
2. Flush sample-extraction point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter coolant into a clean container.
4. Close drain valve (1).
5. Using the equipment and chemicals of the MTU test kit, check the coolant for:
  - Antifreeze concentration
  - Corrosion inhibitor concentration
  - pH value.
6. For coolant change intervals, see (→ MTU Fluids and Lubricants Specifications).



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## 7.15.7 Coolant filter – Replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Coolant filter	(→ Spare Parts Catalog)	

#### WARNING



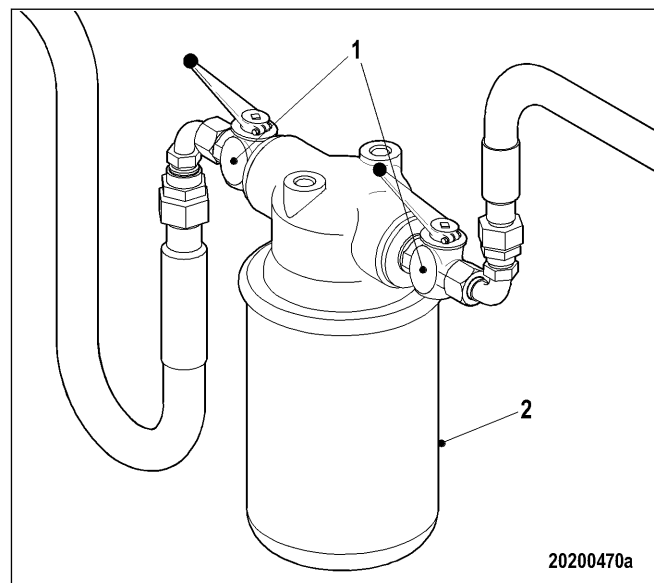
Coolant is hot and under pressure.

#### **Risk of injury and scalding!**

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Coolant filter – Replacement

1. Close shut-off cocks (1).
2. Remove coolant filter (2) with filter wrench.
3. Clean sealing surface on connecting piece.
4. Coat seal on new coolant filter with engine oil.
5. Screw on coolant filter and tighten hand-tight.
6. Open shut-off cocks (1).



## 7.16 Low-Temperature Circuit

### 7.16.1 Charge-air coolant – Level check

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### WARNING



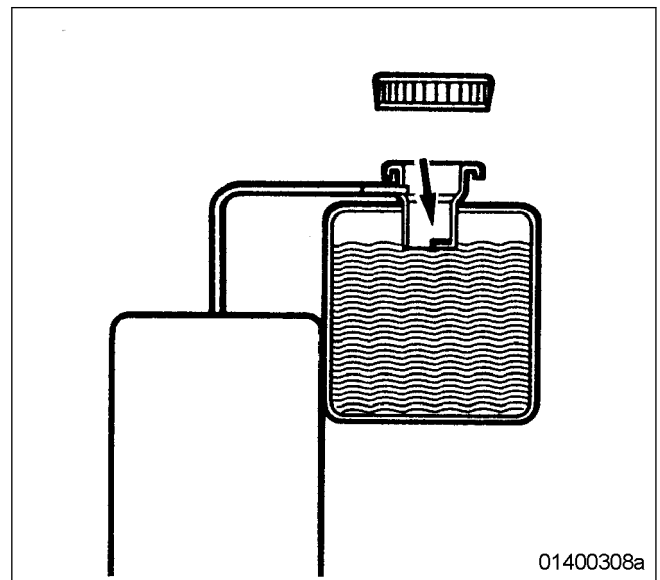
Coolant is hot and under pressure.

#### Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Checking charge-air coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at marking plate).
4. Top up coolant if necessary (→ Page 116).
5. Check proper condition of breather valve, clean sealing faces if required.
6. Fit breather valve and close it.



#### Checking charge-air coolant level by means of level sensor:

1. Switch on engine control system and check display (coolant level is automatically monitored by engine control system).
2. Top up coolant if necessary (→ Page 116).

7.16.2 Charge-air coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		

Drain charge-air coolant.

- ▶ (→ Page 115)

Fill with charge-air coolant.

- ▶ (→ Page 116)

## 7.16.3 Charge-air coolant – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



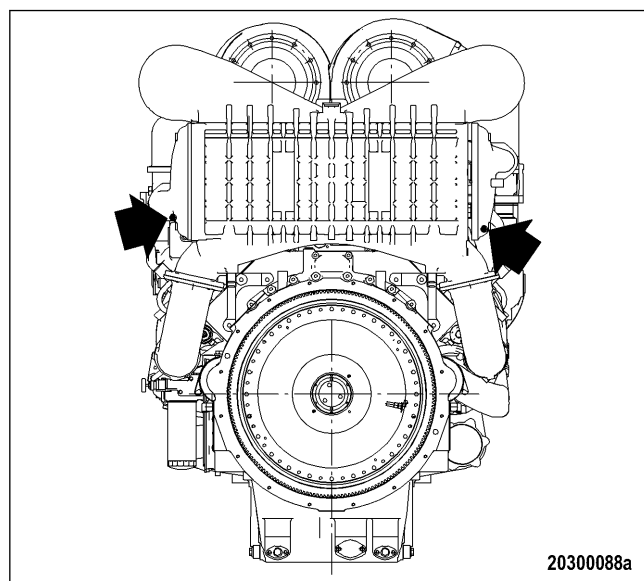
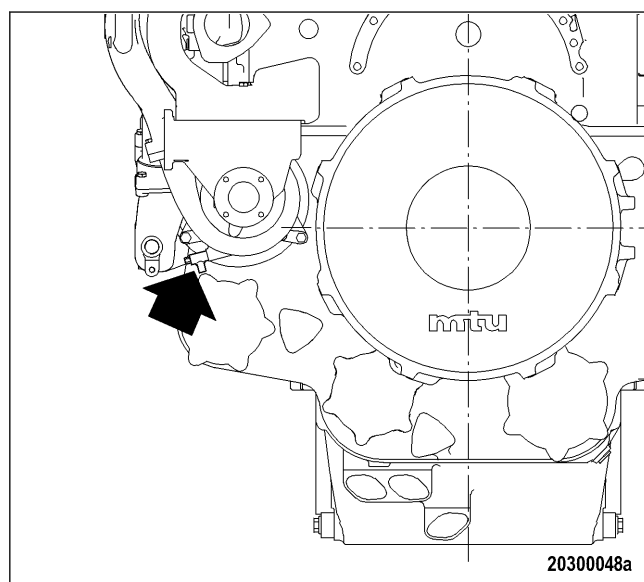
Coolant is hot and under pressure.

#### Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Charge-air coolant – Draining

1. Provide an appropriate container to drain the coolant into.
2. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
5. Open drain valve or plug screw and drain coolant at the LT coolant pump.
6. Drain residual coolant at intercooler, left and right side.
7. Close all drain valves and install drain plugs with new sealing rings.
8. Close breather valve of filler neck.



## 7.16.4 Charge-air coolant system – Filling

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**  
• Wear ear protectors.

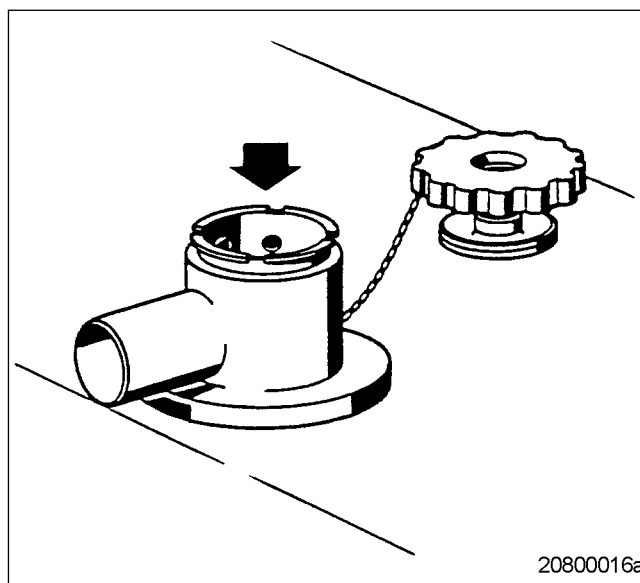
#### CAUTION



Cold coolant in hot engine can cause thermal stress.  
**Formation of cracks in components!**  
• Fill / top up coolant only into cold engine.

### Preparatory steps

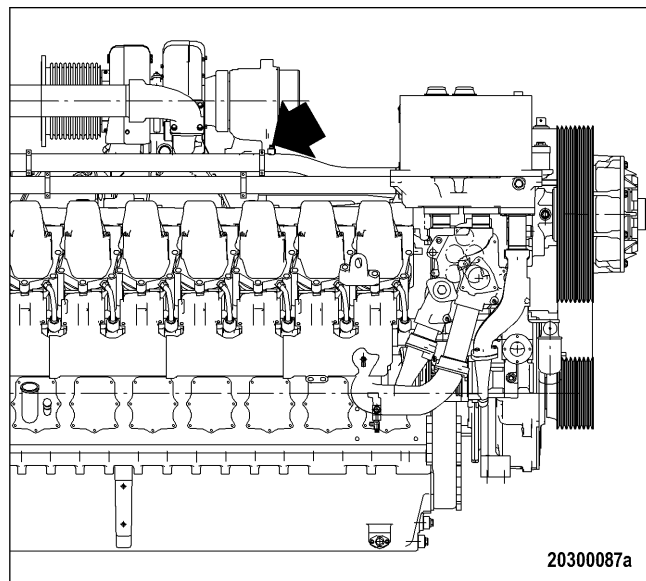
1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Remove plugs from filling points on the coolant lines from and to the intercooler.





## Charge-air coolant system – Filling

1. Pour treated coolant via the filling point on the coolant line from and to the intercooler and via the filler neck of the expansion tank until coolant is visible at the marking plate.
2. Install plugs with new sealing rings at the filling points.
3. Check proper condition of breather valve, clean sealing faces if required.
4. Set breather valve onto filler neck and close it.



## Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 113).

### 7.16.5 Charge-air coolant pump – Relief bore check

#### DANGER



Unguarded rotating and moving engine components.

**Risk of serious injury – danger to life!**

- Take special care when working on a running engine.

#### WARNING



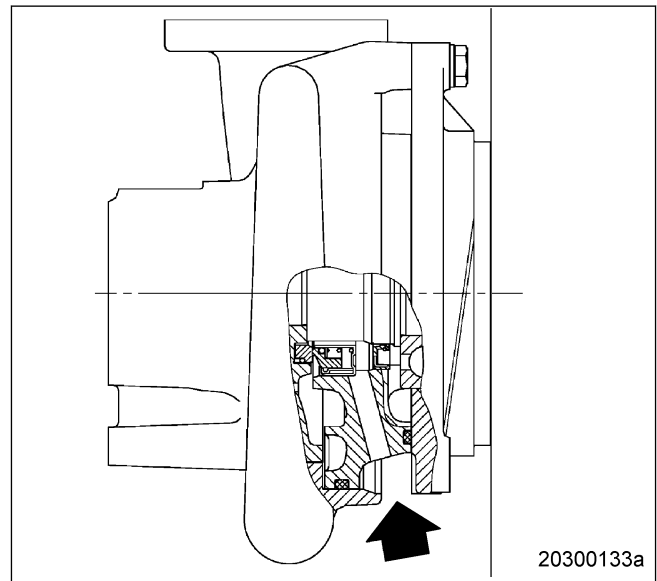
Engine noise above 85 dB (A).

**Risk of damage to hearing!**

- Wear ear protectors.

#### Charge-air coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 37) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
  - Permissible coolant discharge: up to 10 drops per hour.
  - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.

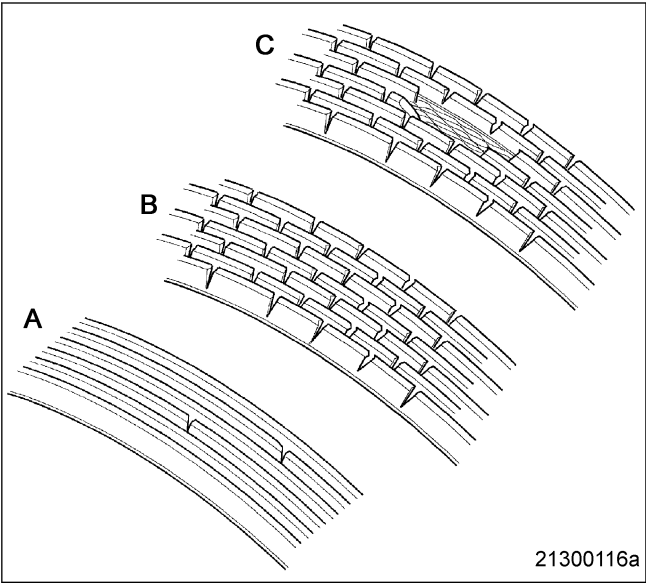


# 7.17 Belt Drive

## 7.17.1 Drive belt – Condition check

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Guard is removed.



Item	Findings	Task
Drive belt A	Breaks in a few individual places	None
Drive belt	Belt is oily, shows signs of over-heating	Fit new belt (→ Page 124)
Drive belt B	Breaks around the entire circumference	
Drive belt C	Areas of belt material missing	

## 7.18 Battery-Charging Generator

### 7.18.1 Battery-charging generator – Removal

#### Preconditions

- ☒ Engine is stopped and starting disabled

#### WARNING



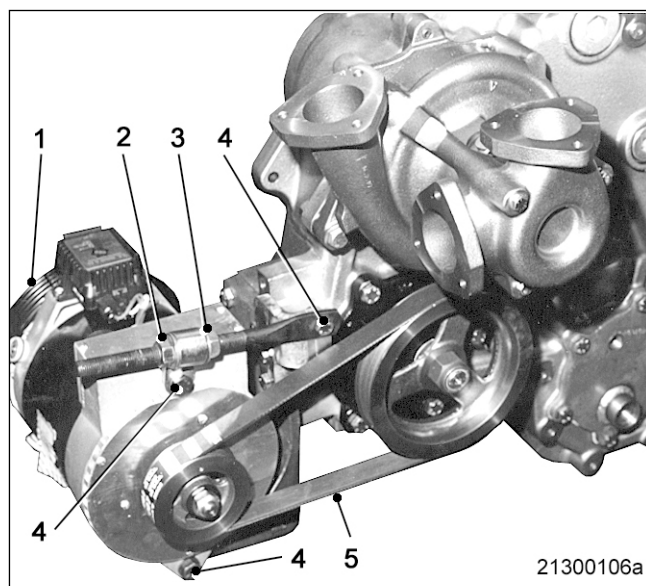
Heavy object.

**Risk of crushing!**

- Use appropriate lifting devices and appliances.

#### Battery-charging generator – Removal

1. Remove guard cover.
2. Label and disconnect electrical cables on battery-charging generator.
3. Protect all cables against damage.
4. Undo nut (3).
5. Tilt battery-charging generator (1) towards engine and remove V-belt (5).
6. Unscrew nut (2) from stud.
7. Unscrew bolts (4) and carefully remove battery-charging generator with bracket and stud
8. Clean battery-charging generator thoroughly (→ Page 121).
9. Assemble in reverse order.
10. Adjust drive belt (→ Page 122).



### 7.18.2 Battery-charging generator – Check

#### Preconditions

- ☑ Engine is stopped and starting disabled.

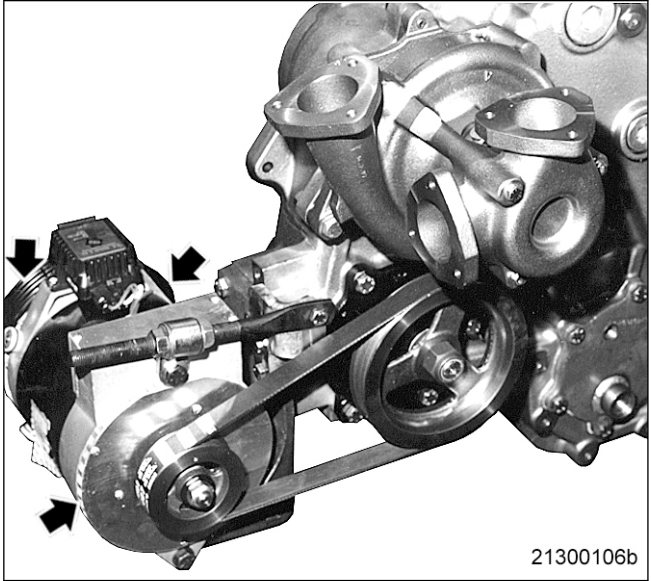
#### WARNING



Compressed air

#### Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.



21300106b

#### Battery-charging generator check

Item	Diagnosis	Task
Ventilation area (arrow)	Clean	None
Ventilation area (arrow)	Dirty	Clean

#### Battery-charging generator cleaning

- Note: Dry-clean battery-charging generator only.
1. Remove thick dirt from battery-charging generator.
  2. Blow out ventilation area (arrow) with compressed air until all dust is cleared.

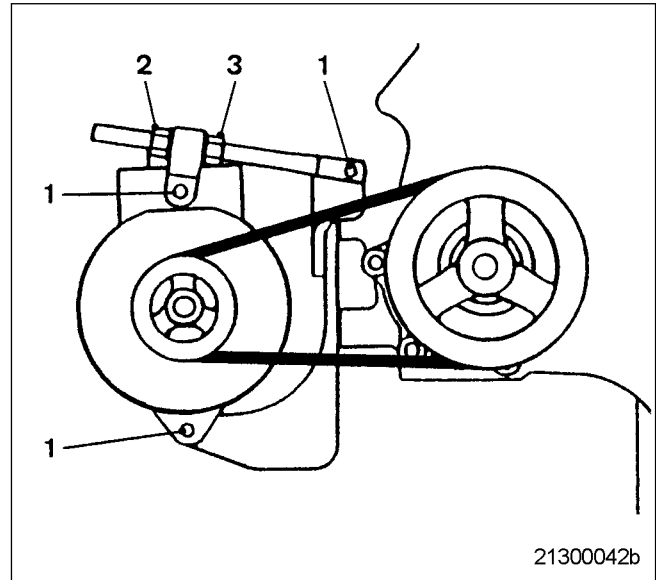
### 7.18.3 Battery-charging generator drive – Drive belt tension adjustment

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### Adjusting belt tension

1. Loosen locknut (2) and screws (1).
2. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 123).
3. Tighten locknut (2).
4. Tighten screws (1).
5. Install guard cover.



## 7.18.4 Battery-charging generator drive – Drive belt tension check

### Preconditions

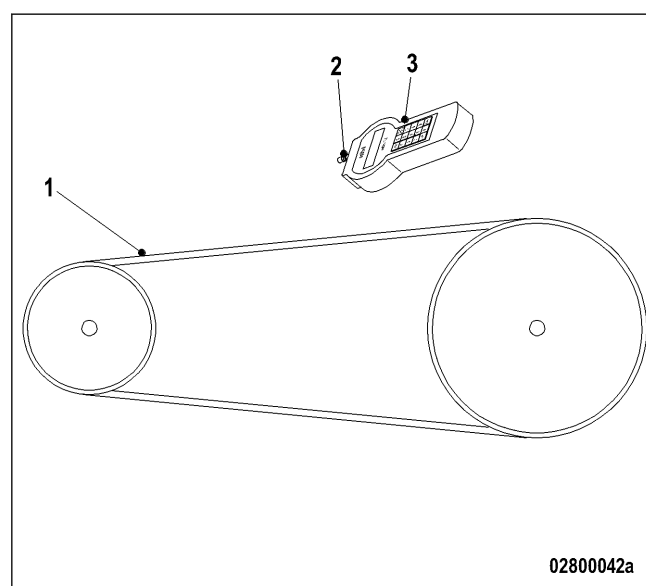
- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Belt tension tester	Y4345711	1

### Preparatory steps

1. Remove guard cover.
2. Check belt condition visually (→ Page 119).



### Checking drive belt tension

1. Fit measuring head (2) on belt-tension tester (3) and hit drive belt (1) with a suitable tool.
2. Hold belt tension tester over belt drive until the measured value is displayed. For specifications, refer to table below.

Application	Value for new drive belt	Value for used drive belt
Series 4000	92 Hz to 96 Hz	80 Hz to 84 Hz

3. If the measured values deviate from the specifications above, adjust drive belt tension (→ Page 122).

## 7.18.5 Battery-charging generator drive – Drive belt replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

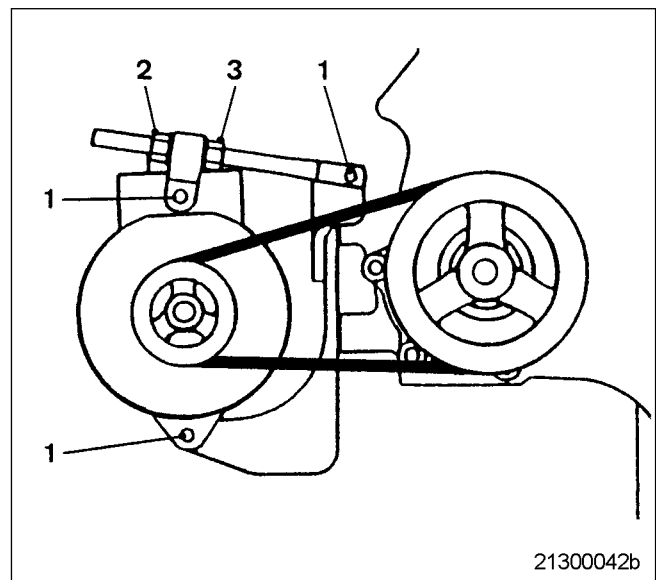
### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

**Note:** In the event of drive belt failure during engine operation fit a new drive belt as quickly as possible. Non-compliance with these instructions may lead to severe consequential damage to drive unit and gear train, since pretension by the drive belt is no longer provided. Therefore, engine operation without drive-belt connection is not allowed.

### Battery-charging generator drive – Drive belt replacement

1. Remove guard cover.
2. Loosen locknut (2) and screws (1).
3. Release drive belt with tensioning nut (3) and take off belt.
4. Clean belt pulleys.
5. Fit new drive belt.
6. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 122).
7. Tighten locknut (2).
8. Tighten screws (1).
9. Install guard cover.
10. Check belt tension after 30 minutes and again after 8 hours engine runtime.





## 7.19 Fan Drive

### 7.19.1 Fan drive belt– Tension check / adjustment

#### Preconditions

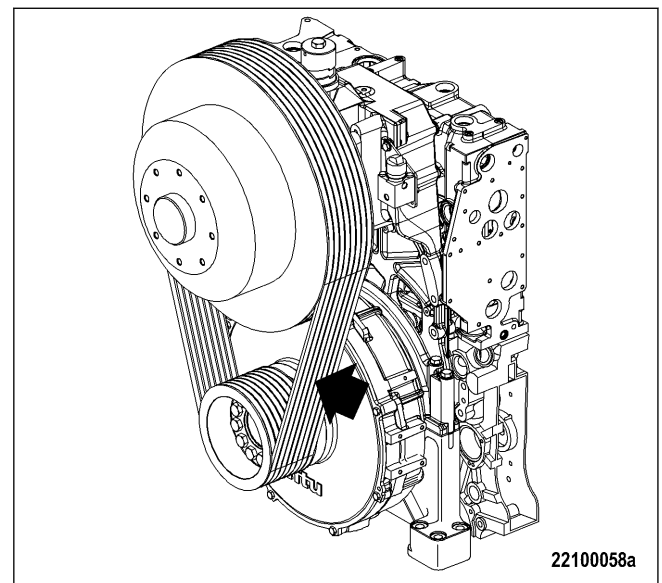
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Optibell 2 belt tension tester	Y4345711	1

#### Preparatory steps

1. Remove guard cover.
  2. Check belt condition visually (→ Page 119).
- Result: If required, replace drive belt (→ Page 127).



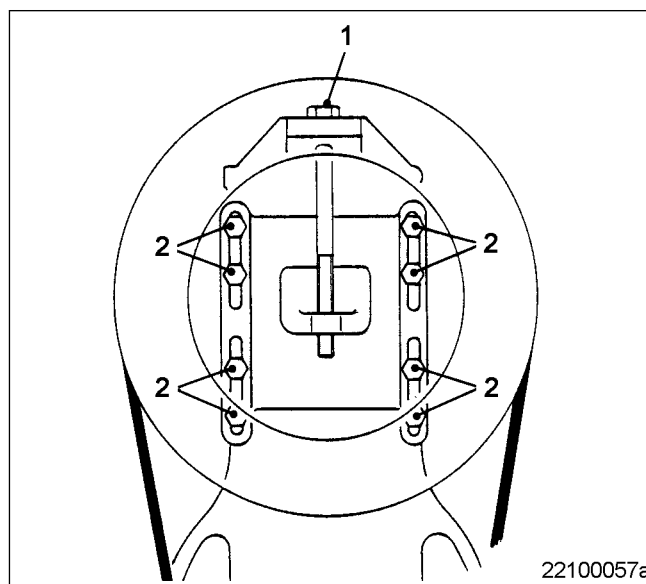
#### Checking Vee belt tension

1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrowed) with a suitable tool.
3. Hold belt tension tester over belt drive until the measured value is indicated.

Initial assembly at MTU	Initial operation with fan	Belt tension adjustment
36 Hz ± 5 Hz	49 Hz ± 5 Hz	44 Hz ± 5 Hz

### Adjusting drive belt tension

1. Release screws (2) until fan coupling can be moved.
2. Tighten stud (1) until the required frequency is achieved.
3. Tighten screws (2) to  $250 \text{ Nm} \pm 25 \text{ Nm}$ .



## 7.19.2 Fan drive – Drive belt replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

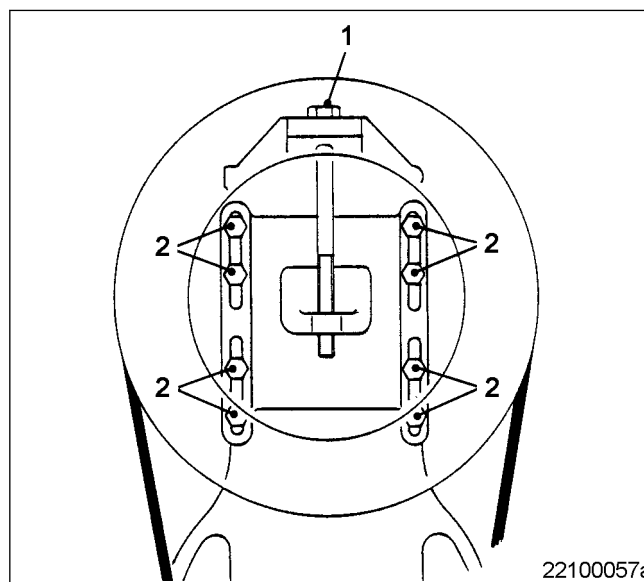
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

### Preparatory steps

1. Remove protective cover.
2. Remove fan.

### Replacing drive belt

1. Release screws (2).
2. Slacken off stud (1) until drive belt can be removed.
3. Clean belt pulleys.
4. Fit new drive belt on belt pulleys, ensuring that it is not under tension.
5. Adjust belt tension (→ Page 125).



## 7.20 Wiring (General) for Engine/Gearbox/Unit

### 7.20.1 Engine wiring – Check

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

#### Engine wiring – Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
  2. Ensure that cables are fixed in their clamps and cannot swing freely.
  3. Check that cable ties are firm, tighten loose cable ties.
  4. Replace faulty cable ties.
  5. Visually inspect the following electrical line components for damage:
    - connector housings;
    - contacts;
    - sockets;
    - cables and terminals;
    - plug-in contacts.
  6. (→ Contact Service) if cable conductors are damaged.
- Note: Close male connectors that are not plugged in with the protective cap supplied.
7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.
  8. Ensure that all sensor connectors are securely engaged.

## 7.21 Accessories for (Electronic) Engine Governor / Control System

### 7.21.1 Engine control unit and connectors – Cleaning

#### Preconditions

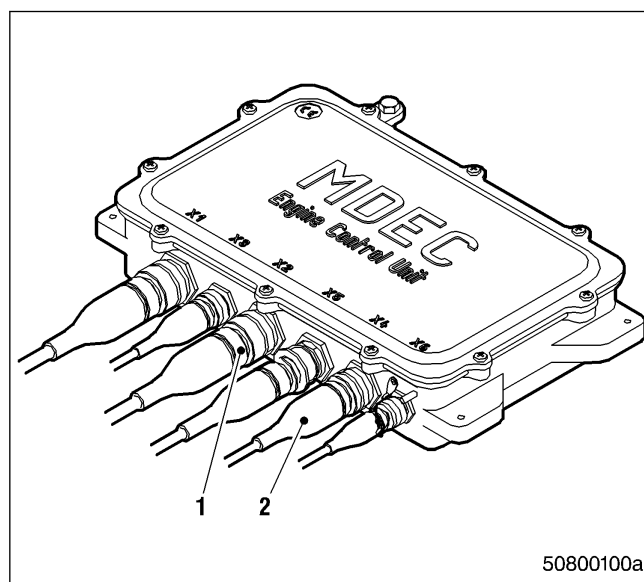
- ☑ Engine shut down and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1
Isopropyl alcohol	46181	1

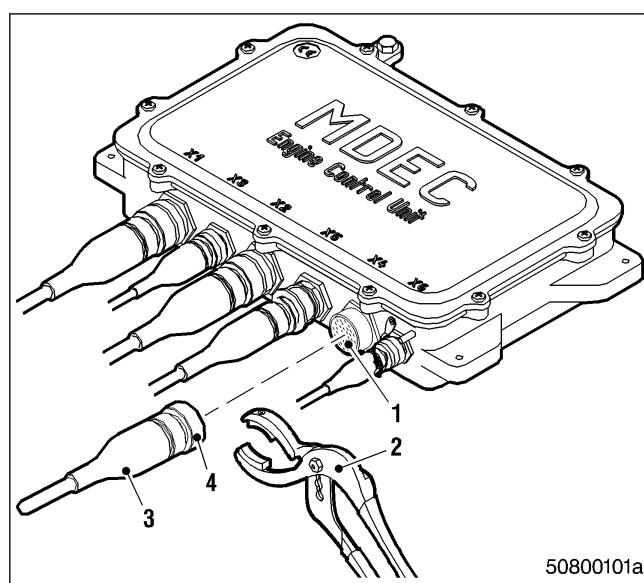
#### Cleaning engine control unit and connectors

1. Remove heavy soiling from housing surface with isopropyl alcohol.
2. Remove dirt from surface of connectors (1), connector sockets and shrink-formed components (2) using a cloth moistened with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.



#### Cleaning heavily soiled connectors on engine control unit

1. Use connector pliers (2) to disengage bayonet union nut (4) and withdraw connector (3).
2. Clean connector housings, connector socket housings (1) and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and check engine control unit plug connections (→ Page 130).



7.21.2 Engine governor plug-in connections – Check

**Preconditions**

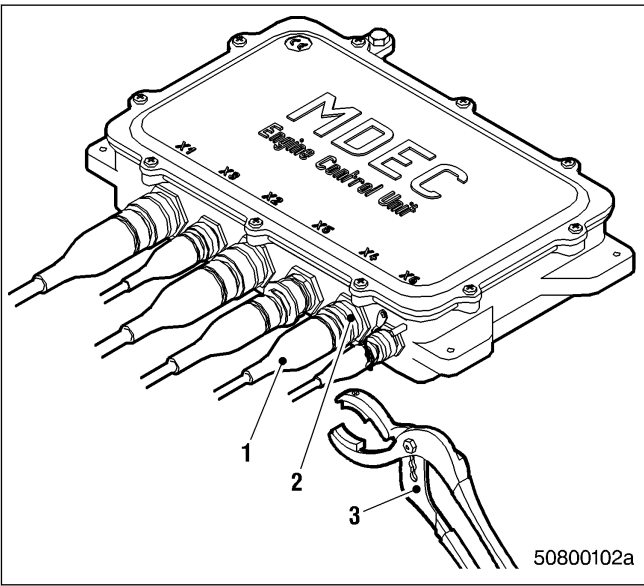
- ☑ Engine is stopped and starting disabled.

**Special tools, Material, Spare parts**

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

**Engine governor plug-in connections – Check**

1. Use connector pliers (3) to make certain that all plug-in connections on engine governor are securely seated.
2. Tighten loose bayonet couplings (2) with connector pliers (3) by turning them clockwise until they latch into place.
3. Ensure that unassigned connector sockets are protected with caps.
4. If bayonet couplings are defective, contact Service.



## 8 Appendix A

### 8.1 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital	Transformer: transforms sensor voltages into numeric values
ADEC	Advanced Diesel Engine Controller	Engine management system
AFRS	Air Filter Restriction Sensor	
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
ATS	Air Temperature Sensor	
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Fluids and Lubricants Specifications, Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Setting of drift compensation in engine governor with DiaSys
CEL	Stop Engine Light	1st function: Warning lamp (rectify fault as soon as possible) 2nd function: Read out fault codes
CKT	Circuit	
CLS	Coolant Level Sensor	Monitors coolant level
CPS	Coolant Pressure Sensor	Monitors coolant pressure
CTS	Coolant Temperature Sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	Diagnostic lines
DDR	Diagnostic Data Reader	Diagnostic unit
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DOC	Diesel Oxidation Catalyst	Oxidation catalyst upstream of the diesel particulate filter
DPF	Diesel Particulate Filter	
DT	Diagnostic Tool	Diagnostic unit
ECM	Electronic Control Module	Electronic control unit of the DDEC system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EEPROM	Electrically Erasable Programmable Read Only Memory	
EFPA	Electronic Foot Pedal Assembly	

Abbreviation	Meaning	Explanation
EGR	Exhaust Gas Recirculation	
EMU	Engine Monitoring Unit	
ETK	Ersatzteilkatalog	Spare Parts Catalog (SPC)
EUI	Electronic Unit Injector	
FPS	Fuel Pressure Sensor	Monitors fuel pressure
FRS	Fuel - Differential Pressure Sensor	
FTS	Fuel Temperature Sensor	Monitors fuel temperature
FWCP	Fire Water Control Panel	Control cabinet
GND	Ground	
HD	Hochdruck	High Pressure (HP)
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit value
HT	High Temperature	
IDM	Interface Data Module	Memory module for interface data
INJ	Injector	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LED	Light Emitting Diode	
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LSG	Limiting Speed Governor	
N/A	Not Applicable	
LP	Low Pressure	
OEM	Original Equipment Manufacturer	
OI	Optimized Idle	
OLS	Oil Level Sensor	Monitors oil level
OPS	Oil Pressure Sensor	Monitors oil pressure
OTS	Oil Temperature Sensor	Monitors oil temperature
OT	Oberer Totpunkt	Top Dead Center (TDC)
PAN	Panel	Control panel
PIM	Peripheral Interface Module	
PWM	Modulated signal	
P-xyz	Pressure-xyz	Pressure measuring point, xyz specifies the measuring point designation
RL	Redundancy Lost	Alarm: Redundant CAN bus failure



Abbreviation	Meaning	Explanation
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SEL	Stop Engine Light	1st function: Warning lamp (stop engine and rectify fault) 2nd function: Read out fault codes
SID	System Identifier	
SRS	Synchronous Reference Sensor	TDC cylinder 1
SS	Safety System	Safety system alarm
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point, xyz specifies the measuring point designation
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
VNT	Variable Nozzle Turbine	
VSG	Variable-Speed Governor	
VSS	Vehicle Speed Sensor	
WZK	Werkzeugkatalog	Tool Catalog (TC)

## 8.2 MTU contacts/service partners

### **Service**

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

### **Local support**

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU internet site: <http://www.mtu-online.com>

### **24h hotline**

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you - either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact at Headquarters: [Service-support@mtu-online.com](mailto:Service-support@mtu-online.com)

### **Spare parts service**

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system

- a central depot at Headquarters, as well as decentralized depots among our subsidiaries, representatives and contractual workshops.

Your contact at Headquarters:

E-mail: [spare.parts@mtu-online.com](mailto:spare.parts@mtu-online.com)

Phone: +49 7541 908555

Fax: +49 7541 908121

## 9 Appendix B

### 9.1 Special Tools

#### Air filter

Part No.:

Qty.:

Used in: 7.11.2 Air filter – Replacement (→ Page 92)

#### Coolant filter

Part No.:

Qty.:

Used in: 7.15.7 Coolant filter – Replacement (→ Page 112)

#### Diaphragm

Part No.:

Qty.:

Used in: 7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 63)

#### Drive belt

Part No.:

Qty.:

Used in: 7.18.5 Battery-charging generator drive – Drive belt replacement (→ Page 124)

Qty.:

Used in: 7.19.2 Fan drive – Drive belt replacement (→ Page 127)

#### Easy-change filter

Part No.:

Qty.:

Used in: 7.9.1 Fuel filter – Replacement (→ Page 86)

#### Filter element

Part No.:

Qty.:

Used in: 7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 63)

Qty.:

Used in: 7.3.3 Crankcase breather – Filter element replacement (→ Page 66)

#### Filter sleeve

Part No.:

Qty.:

Used in: 7.14.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 103)

Gasket	
Part No.:	
Qty.:	
Used in:	7.5.3 Cylinder head cover – Removal and installation (→ Page 76)
Grounding device	
Part No.:	
Qty.:	
Used in:	7.4.2 Grounding device – Replacement (→ Page 69)
Injector	
Part No.:	
Qty.:	
Used in:	7.7.1 Injector – Replacement (→ Page 78)
O-ring	
Part No.:	
Qty.:	
Used in:	7.14.1 Automatic oil filter – Filter candles replacement (→ Page 98)
Qty.:	
Used in:	7.14.2 Oil indicator filter – Check (→ Page 101)
Oil filter candles	
Part No.:	
Qty.:	
Used in:	7.14.1 Automatic oil filter – Filter candles replacement (→ Page 98)
Seal	
Part No.:	
Qty.:	
Used in:	7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 63)
Qty.:	
Used in:	7.11.1 Air filter element and dust bowl – Cleaning (→ Page 90)
Qty.:	
Used in:	7.11.3 Air filter element – Removal and installation (→ Page 93)

### Sealing ring

Part No.:

Qty.:

Used in: 7.9.2 Edge-type fuel filter – Draining (→ Page 87)

Qty.:

Used in: 7.13.2 Engine oil – Change (→ Page 97)

Qty.:

Used in: 7.14.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 103)

Qty.:

Used in: 7.14.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 103)

Qty.:

Used in: 7.16.3 Charge-air coolant – Draining (→ Page 115)

Qty.:

Used in: 7.16.4 Charge-air coolant system – Filling (→ Page 116)

### Square-section ring

Part No.:

Qty.:

Used in: 7.14.2 Oil indicator filter – Check (→ Page 101)

### Strainer

Part No.:

Qty.:

Used in: 7.14.2 Oil indicator filter – Check (→ Page 101)

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